



# BOURNE COMMUTER RAIL FEASIBILITY STUDY

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## EXECUTIVE SUMMARY

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The opening of the Middleborough/Lakeville commuter rail line in September 1997, part of the restoration of the Old Colony railroad, raises the possibility for a further extension to the town of Bourne, on Cape Cod. Part of the rationale for such an extension is the trend toward longer commuting trips; in fact, as of 1990, more than 2,000 people commuted to Boston from Wareham and the towns on the Cape.

This study, responding to a provision in the 1995 Transportation Bond Act, examines the feasibility of extending service from the Middleborough/Lakeville line to the town of Bourne, with an intermediate station in Wareham. Terminals at Buzzards Bay and Sagamore are both considered. The study includes forecasts of ridership and costs and some analysis of the environmental impacts of such an extension.

### Project Description

The extension of Massachusetts Bay Transportation Authority (MBTA) commuter rail service from Middleborough to the Buzzards Bay or Sagamore areas in the town of Bourne would use an existing rail line known as the Buzzards Bay Secondary Track. This line is now used primarily for freight service, but also carries intercity passenger trains between Amtrak's Northeast Corridor and points on Cape Cod on summer weekends. The line runs from Middleborough, through a corner of Rochester and the center of Wareham, to Bourne (see map on next page).

Identification of specific station locations is beyond the scope of this study. Geographic limitations at Buzzards Bay allow little choice other than the present Amtrak station site for location of platforms and waiting facilities there. The existing Wareham Station site used by Amtrak has limited parking and no room for surface expansion. In the past, railroad stations existed at several other locations in the town. None of these (nor any other location on the line) would be clearly superior to the existing site in terms of access routes, but they may have more room for parking. Population densities and access routes would not justify provision of any stations between the Wareham/Rochester town line and the Middleborough/Lakeville station.

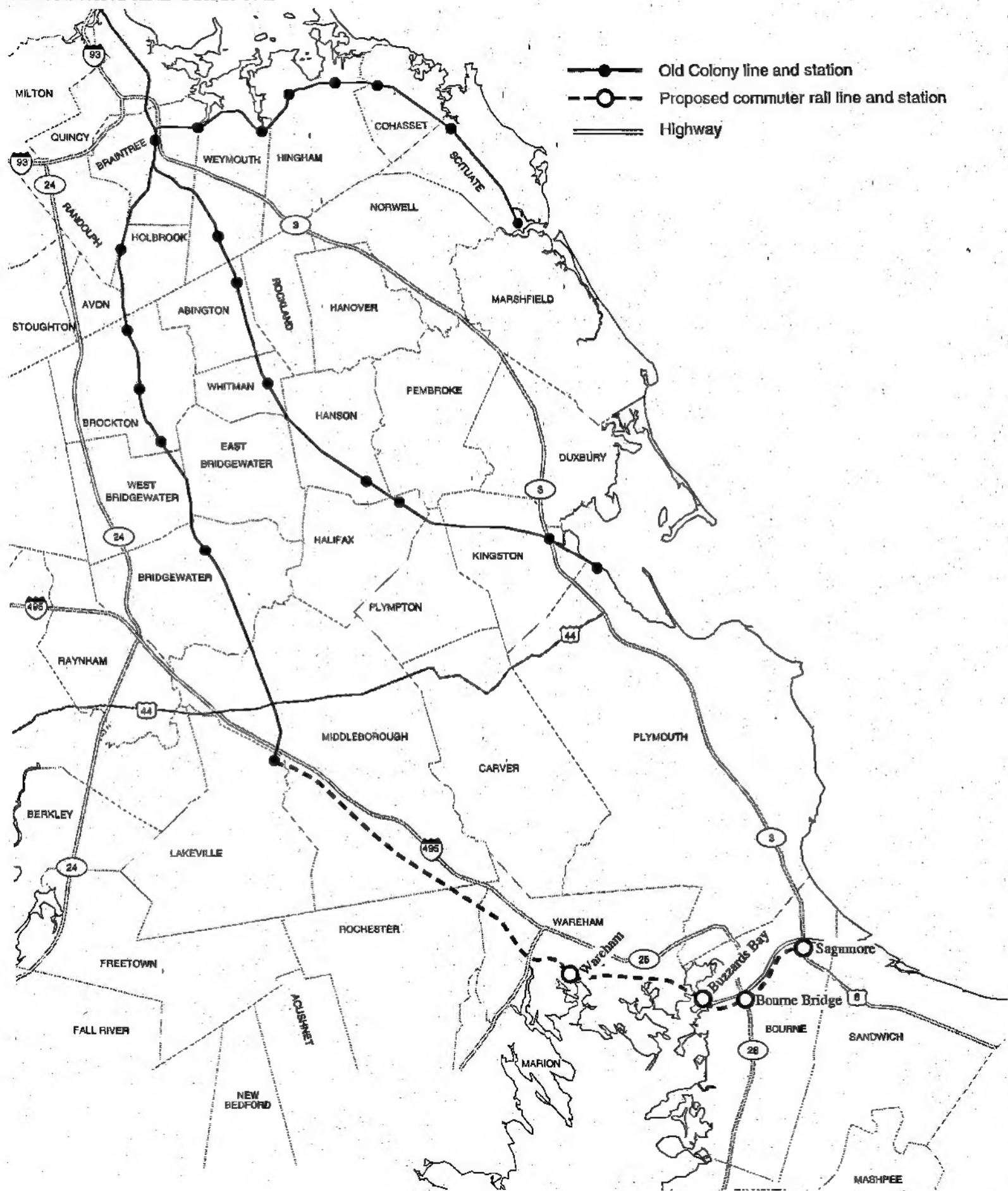
Most of the market for travel from Cape Cod to Boston would be better served by an extension continuing south of the canal than by one terminating at Buzzards Bay. An extension along the line to Hyannis (used by the Amtrak seasonal trains) would serve most of the population of commuters to Boston through stations near the south ends of the Bourne and Sagamore bridges. These stations, if they included sufficient parking, could provide commuters with an easily accessible alternative to crossing the bridge and driving all the way into the urban core.



# BOURNE COMMUTER RAIL

Feasibility Study

## ALIGNMENT AND STATIONS





The travel times and fares to South Station in Boston from the potential stations on the extension would be as shown in Table 1:

Table 1  
Travel Times and Fares from Potential Bourne Extension Stations  
to South Station

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Wareham	75 min.	Zone 9 (\$4.75)
Buzzards Bay	82 min.	Zone 10 (\$5.50)
Bourne Bridge	86 min.	Zone 10 (\$5.50)
Sagamore	93 min.	Zone 10 (\$5.50)

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### **Ridership Potential**

The primary travel market served by a Bourne commuter rail extension would consist of work trips to Boston from Wareham, Bourne, and inner Cape Cod communities as far south as Barnstable. The predominant travel mode for this traffic is currently private automobile, although well-established express bus services to Boston from Wareham and towns on Cape Cod, provided by Bonanza Bus Lines and the Plymouth & Brockton Street Railway Company, carry about 710 inbound A.M. peak riders on a typical weekday.

Ridership on a commuter rail extension to Bourne, assuming that some private carrier express bus service would continue to operate, would be about 1,200 inbound weekday riders in 1996. This demand estimate is not dependent on the specific outer terminal location, but parking and access capacity constraints for an extension terminating at Buzzards Bay could hold ridership below this figure, while an extension all the way to Sagamore with sufficient parking could push ridership somewhat higher. Table 2 below shows the estimated number of boardings by town of origin.

There would be some overlap between the service area of a Bourne commuter rail extension and the expected service area of the Old Colony commuter rail restoration project. Of the predicted riders for a Bourne extension under all sets of assumptions, roughly 200 would board Old Colony trains at either Kingston or Middleborough/Lakeville if there were no extension.

Ridership for future years was estimated using the latest population and employment forecasts. By 2010, ridership is predicted to increase to approximately 1,300. The current employment forecast assumes that there will be some decline in employment by the year 2020. Thus the ridership forecast shows little increase between 2010 and 2020, growing to just over 1,300.

Table 2  
1996 Estimated Weekday Inbound Ridership on Bourne Extension  
by Town of Origin

<u>Town</u>	<u>Mid-Range Demand Estimate with Bus Service Retained</u>	<u>Diversions from Middleborough/ Lakeville or Kingston</u>
Wareham	270	5
Rochester	50	0
Marion	30	5
Mattapoisett	30	0
Bourne	120	20
Falmouth	145	20
Sandwich	175	45
Mashpee	90	20
Barnstable	215	50
Yarmouth	40	15
Dennis	20	5
Rest of Cape Cod	15	10
Total	1,200	195

### Capital Cost Estimates

The main capital costs for commuter rail extensions generally consist of construction or upgrading of tracks, signals, bridges, and crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. The capital costs estimated below are based on unit costs typical for MBTA commuter rail extensions. More detailed engineering studies would be needed in order to finalize these estimates.

#### *Tracks, Signals, and Crossings*

A Bourne extension would operate entirely over single-track lines which were rebuilt in 1986 in conjunction with the startup of Amtrak summer service. Some additional investment is needed to bring these lines up to commuter rail system standards, however. The total cost of the work for the segment between Middleborough and Buzzards Bay would range up to \$1.4 million. If the Bourne extension is to terminate at Sagamore rather than Buzzards Bay, an allowance of \$1.3 million should be included for upgrading the track on the bridge and south of the canal.

Most of the hardware for a wayside signal system is in place on the extension route, but final wiring is needed at undetermined cost. Installation of a cab-signaling system, as is currently planned for the other Old Colony lines, would cost an estimated \$2 million additional.

The grade crossings of public roads between Middleborough/Lakeville and Buzzards Bay should be rebuilt for 79 m.p.h. rail service. The total expense for this would be about \$350,000. Lights and gates at all crossings are relatively new and are in working order. For 79 m.p.h. service, the track circuits activating the crossing protection would need to be lengthened, but this would entail a minor expense. There are no public grade crossings between Buzzards Bay and Sagamore.

At present, none of the right-of-way between Middleborough/Lakeville and Sagamore is fenced in, except where abutting property owners have installed their own fences. For safety, the right-of-way should be fenced wherever developed land abuts the tracks. A preliminary investigation indicates that between Middleborough/Lakeville and Buzzards Bay segments totaling about ten miles should be fenced, at a cost of \$700,000. South of the canal an additional three miles should be fenced, at a cost of \$210,000.

#### ***Stations and Parking; Layover Facility***

The operating plan for the Old Colony lines calls for limited personnel on board trains. Stations will have high-level platforms, and coach doors will be opened and closed remotely from a central location on each train. For compatibility with this, stations on a Bourne extension would also require high-level platforms.

A contract recently awarded for construction of high-level platforms, shelters, and benches on the Plymouth and Middleborough/Lakeville Old Colony branches has an average of \$804,000 per station. Most of these stations will be built at sites where there have not been stations previously. Stations at the Bourne Bridge and Sagamore and at sites in Wareham other than the present Amtrak station could be expected to have similar costs for the same items. Real estate acquisition costs would be in addition to these, and would be site-specific. Replacement of the platforms at the Buzzards Bay and Wareham Amtrak stations with high-level platforms should cost less than the \$804,000 each at locations requiring initial site preparation.

According to the demand estimates discussed above, approximately 975 new parking spaces would be needed to meet summer demand. The average cost of constructing surface parking lots at commuter rail stations is about \$3,000 per space. At this rate, parking facilities on a Bourne extension would cost \$2,925,000. Because of limited site sizes, at least some of the parking might have to be in structures rather than in surface lots. The cost for structured parking is about \$15,000 per space. With all parking being in structures, the cost would be \$14,625,000.

A Bourne extension should include an overnight layover facility for trains somewhere near the outer terminal to minimize expenses of non-revenue train

operation. The cost of a facility with sufficient capacity for all trains on the Middleborough/Lakeville route would be about \$2 million.

### ***Rolling Stock***

Commuter rail service to Bourne would be operated by extending trains that would otherwise run to Middleborough/Lakeville Station, but the additional ridership from stations on the extension would require more cars per train. Assuming that train lengths would be sufficient to provide seats for all riders, and that additional capacity for extension riders would be provided by adding double-deck cars with seating capacities of 185 each, a total of five cars would need to be added to the first four trains. The additional train set needed to maintain the current schedule on the Middleborough/Lakeville line would have a locomotive and five cars.

Currently locomotives cost about \$2.2 million each and double-deck coaches about \$1.6 million each. For the rolling stock requirements specified above, the cost would be \$18.2 million.

**Table 4**  
**Summary of Capital Costs for Bourne Extension**

	<u>Middleborough to Buzzards Bay</u>	<u>Buzzards Bay to Sagamore</u>	<u>Total</u>
Track and Signals	\$3,000,000	\$1,400,000	\$4,400,000
Track Work on Lift Bridge	0	250,000	250,000
Resurfacing Road Crossings	350,000	0	350,000
Right-of-Way Fencing	700,000	210,000	910,000
Station Platforms and Shelters	1,608,000	804,000	2,412,000
		(see note)	
Parking (assuming surface lots)	2,925,000	(see note)	2,925,000
Layover Facility	2,000,000	(see note)	2,000,000
10% Contingency Factor	1,058,000	267,000	1,325,000
Rolling Stock	<u>18,200,000</u>	<u>0</u>	<u>18,200,000</u>
Total	\$29,841,000	\$2,931,000	\$32,772,000

**Notes:** Station Platform and Shelter costs assume that with a Sagamore terminal, no improvements at the existing Buzzards Bay Station would be needed because of the low remaining ridership there.

The total number of parking spaces would be the same with either terminal, the only difference being their location. Therefore, a Sagamore extension would not increase parking cost compared with a Buzzards Bay terminal.

There would be one layover facility, located near the outer terminal.

If site constraints were to make it necessary to use structured parking, this could increase the project cost by up to \$13 million. Excluding parking facilities, an extension terminating at Buzzards Bay would cost about \$3 million less than an extension to Sagamore. A Buzzards Bay terminal would be more likely to require structured parking because of the more limited site availability north of the canal, however. It should be emphasized that these are approximate cost figures, and that more detailed engineering studies would be required to refine them.

### Operating Cost and Revenue Estimates

Operating costs for a Bourne extension were calculated assuming that service would be provided by extending trains that would run between Boston and Middleborough/Lakeville anyway, and that all trains on that route would continue to Bourne. There would be 14 round trips on weekdays, 9 on Saturdays, and 7 on Sundays. Costs were calculated for extensions terminating at Buzzards Bay and at Sagamore. For each option, it was assumed that a layover facility would be built in the vicinity of the terminal. The annual operating costs for the two options would be \$6.69 million for a Buzzards Bay extension and \$8.58 million for a Sagamore Bridge extension.

Under the present fare structure, at the estimated ridership level of 1,200 weekday riders and weekend ridership in typical proportion to this, the annual revenue and operating deficit would be as shown in Table 3 below:

Table 3  
Comparison of 1996 Operating Cost and Revenue

	Operating Cost	Annual Revenue	Operating Deficit	Fare Recovery Ratio
Buzzards Bay terminal	\$6.69m	\$2.4 m	\$4.26m	36%
Sagamore terminal	\$8.58m	\$2.4 m	\$6.15m	28%

As mentioned above, a Sagamore terminal may cause ridership to be somewhat higher than 1,200, while a Buzzards Bay terminal may hold ridership below 1,200. Therefore, the operating deficits and fare recovery ratios for the two options would tend to converge near \$5 million and 32%, respectively. Using constant costs and fare structure, increases in ridership between the years 1996, 2010, and 2020 would not improve the revenue-to-cost ratios significantly.

## Environmental Impacts of Bourne Extension

### *Impacts on Traffic and Air Quality*

If a Bourne extension were in operation today, with the outer terminal at Buzzards Bay, the midpoint demand estimate would result in a reduction in vehicle miles travelled (VMT) of 53,350 on an average weekday. A further extension with stations at the south ends of the Bourne and Sagamore bridges would shorten access trips for passengers diverted from the Buzzards Bay station. This would increase the VMT reductions to 59,220. These reductions in VMT would result in a reduction in emissions from automobiles of carbon monoxide (CO), nitrous oxides (NOx), and volatile organic compounds (VOC)

At the same time, however, the diesel locomotives used on trains would add emissions to the air. In addition to CO, NOx and VOC, particulate matter (PM) is of concern for diesel vehicles. The net impact of the reduction in auto emissions and increase in locomotive emissions would be as shown in Table 5. As can be seen from the tables, an extension to either Buzzards Bay or Sagamore would result in overall reduction in CO and VOC levels, but increases in NOx and PM levels.

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Table 5  
Net Changes in Average Weekday Emissions

	Buzzards Bay Terminal	Sagamore Terminal
CO change	-512.5 kg	-564.1 kg
NOx change	+166.6 kg	+234.5 kg
VOC change	-41.9 kg	-44.8 kg
PM change	+3.5 kg	+4.5 kg

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### *Traffic Impacts on Major Arterial Routes*

The largest reduction in traffic as a result of the extension would occur on the Southeast Expressway. At 1996 traffic levels, there would be a reduction of approximately 700 cars on an average weekday. The largest reduction in any 30-minute interval would be about 200 autos. South of the Expressway, the traffic reductions would be divided between Route 3 and Route 24.

A Buzzards Bay terminal would increase traffic on the Bourne and Sagamore bridges slightly, because of diversions from bus stops south of the canal. The maximum increase in any 30-minute interval would be 15 cars at the Bourne Bridge and 40 at the Sagamore Bridge. An extension beyond Buzzards Bay with



stations at the south ends of the bridges would decrease traffic by up to 40 cars on the Bourne Bridge and 145 on the Sagamore Bridge in the peak 30 minutes.

### *Impacts of Extension on Surrounding Areas*

A Bourne commuter rail extension would not affect the number of trains operating between Boston and Middleborough, so impacts on surroundings would all occur on the extension itself. The extension would use a rail line that is currently active, but would result in a substantial increase in train frequency. Associated increases in noise and vibration would be expected, but the corridor is relatively lightly populated. A total of about 75 houses are located within 200 feet of the line. Two thirds of these are partially screened from the rail line by cuts or embankments.

There are 11 grade crossings, all of which are protected by flashing lights and all but one of which also has automatic two-quadrant gates. Only one of the crossings (Route 6 in Wareham) appears to have vehicular traffic sufficiently heavy that backups would occur when trains were using it.

Any station sites on a Bourne extension would require some use of local streets for access. With the maximum projected demand levels, this could result in heavy congestion before morning train departures and after evening arrivals. The Buzzards Bay station would have the most problems. If this were the outer terminal on the line, arrivals in the six minutes prior to train departure could average as high as 35 cars per minute at present travel levels. This would be one of the heaviest auto arrival rates anywhere in the commuter rail system. A further extension to Sagamore with an intermediate stop at Bourne would divert almost all of the traffic from Buzzards Bay, however.



## 1. INTRODUCTION

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The Massachusetts Bay Transportation Authority's Old Colony Railroad Rehabilitation Project will restore commuter rail service to Boston from three routes in southeastern Massachusetts. Service on the first two of these routes, to Plymouth and to the Middleborough/Lakeville town line, is scheduled to begin in September 1997. From the Middleborough/Lakeville station site, an existing state-owned rail line continues south through Wareham and Bourne to points on Cape Cod. At present, this line is used mostly for freight service, but on summer weekends it also carries Amtrak passenger trains between the Cape and points in the Northeast Corridor.

Section 6005-9564 of the 1995 state Transportation Bond Bill authorized funds for the MBTA to study whether it is "to establish commuter rail service from the terminus of the Old Colony commuter rail project in the town of Middleborough to the Buzzards Bay area of the town of Bourne." This report presents the results of the feasibility study, which was performed for the MBTA by the Central Transportation Planning Staff.



## 2. SERVICE AREA

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### Communities to Be Served

The primary service area for a Bourne commuter rail extension would consist of the towns directly on the line (Bourne and Wareham) and towns directly adjoining these.<sup>1</sup> (See Service Area map on page 4.) In addition to these towns, this study considers all of the rest of Barnstable County and the town of Mattapoisett to be within the potential market area of a Bourne extension, for the following reasons.

The outer terminals on commuter rail lines often attract riders from greater distances than intermediate stops do. All highway traffic from Cape Cod (except for the northern edge of Bourne) to points outside Barnstable County must cross the Cape Cod Canal either on the Bourne Bridge or on the Sagamore Bridge. The north end of the Bourne Bridge is 1.6 miles from Buzzards Bay Station. The north end of the Sagamore Bridge is five miles from the station. A further rail extension south of Buzzards Bay could intercept traffic even closer to the bridges. Finally, according to Census figures, several Cape Cod towns originate greater numbers of work trips to Boston than Bourne. Mattapoisett would have convenient highway access to a Wareham station and its highway access to Boston is indirect.

### Existing Transportation Services

#### *Present Railroad Facilities in the Study Area*

A commuter rail extension from Middleborough to Bourne would use the existing rail line known as the Buzzards Bay Secondary Track. This line was last used for year-round passenger service to Boston in 1959. Summer-only passenger service in various forms has run on this line every year since 1984.

At Middleborough, the extension would have two rail connections, one to the north and one to the west. The northern connection would be the commuter rail line from Middleborough/Lakeville to Boston, scheduled to open in September 1997. The western connection leads to the MBTA's Attleboro/Stoughton commuter rail line at Attleboro. (This line is also part of Amtrak's Northeast Corridor between Boston, New York, and Washington.) At Buzzards Bay, there are connecting rail lines to Falmouth and Hyannis.

The Buzzards Bay Secondary and its immediate connections are all owned either by the Executive Office of Transportation and Construction (EOTC), or by the

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<sup>1</sup>The extension would also pass through portions of Rochester and Middleborough, but it would not have a station in either town, for reasons discussed elsewhere in this report. Carver and Plymouth adjoin Wareham, but are also considered to be outside the service area.

**T BOURNE COMMUTER RAIL**

Feasibility Study

**SERVICE AREA OF BOURNE COMMUTER RAIL EXTENSION**





MBTA. Year-round freight service on the lines from Middleborough to Buzzards Bay and beyond is currently operated by the Bay Colony Railroad. Summer weekend passenger service between New York and Hyannis, which was operated by Amtrak each summer from 1986 to 1995, also used the Buzzards Bay Secondary. In 1996 Amtrak will instead operate a connecting train from Providence to Hyannis, but the same lines will be used. (These trains will originate in Boston, allowing passengers to ride from there to Cape Cod points via Providence without transferring.) As before, service will run to Hyannis on Friday nights and return on Sunday afternoons. This service is scheduled to run from June 28 to September 27. It will include stops at Wareham and Buzzards Bay as well as at points south of the canal.

The Buzzards Bay Secondary Track passes through sections of four towns: Middleborough, Rochester, Wareham, and Bourne. Buzzards Bay village is part of Bourne, on the north side of the Cape Cod Canal. In Rochester, the rail line passes through the northeast corner of the town for a distance of about 1.5 miles, but is separated from most of the populated sections by swamps and cranberry bogs. The most accessible land along the right-of-way in Rochester is already occupied by a regional trash incinerator and an asphalt mixing plant. There has never been a station on this segment of the railroad, and it is unlikely that there would be one there in the future. Middleborough will be served by the Middleborough/Lakeville Station. As discussed in Chapter 4, a second station in Middleborough on a Bourne extension would not be justified.

#### *Present Highway Facilities Serving Study the Area*

A Bourne commuter rail extension would begin at the outer terminal of the Middleborough/Lakeville commuter rail line. This site is at Exit 4 of Route I-495, which parallels the rail line as far as Wareham. (The straight-line distance between the highway and the railroad is under one mile at most points, but distances via connecting roads are somewhat greater.) State Route 25 continues parallel with the railroad from the end of I-495 to Bourne, and has an exit 1.6 miles from the center of Buzzards Bay. These limited-access highways will provide the fastest road link to the Middleborough/Lakeville commuter rail line from communities in the Middleborough-Bourne corridor.

The Route 25/I-495 combination is part of one of the two main highway routes between Cape Cod and Boston. From I-495, Boston-bound traffic proceeds via Routes 24 and I-93, passing through most of the same cities and towns that will be served by the Middleborough/Lakeville commuter rail line. The other main highway route from the Cape to Boston is state Route 3, which follows a more easterly alignment and joins I-93 in Quincy. Route 3 has more direct access than Route 25 to most towns on the Cape. Its closest point to the Buzzards Bay Secondary Track is at Sagamore Circle, five miles from the traditional Buzzards Bay station site. The Plymouth line of the Old Colony commuter rail service will have a station at Route 3 in Kingston, about 18 miles from Sagamore Circle.

Demand forecasts for the Old Colony Railroad Rehabilitation Project indicate that without a Bourne extension, most Barnstable County residents attracted to commuter rail would use the Kingston station.

Based on information from 1994 and 1995 CTPS travel time runs, an automobile trip from Sagamore Circle to Kneeland Street in Boston via Route 3 would now take about 83 minutes under average traffic conditions in the heaviest travel hour. For cars using the HOV lane on the Southeast Expressway, the time would be about 12 minutes less. From Route 25 Exit 2 in Bourne to Kneeland Street via Route 24, peak hour automobile time would also average about 83 minutes without use of the HOV lane, and about 12 minutes less using it.

Direct travel time comparisons between private automobiles and bus or rail service are difficult, because automobile trips include all or most of the journey from origin to destination, whereas most mass transit trips are made in combination with other access and egress modes. Other sections of this report show rail and bus times between specific station pairs, but no attempt has been made to calculate access and egress times.

The highway distance from Buzzards Bay to the Middleborough/Lakeville terminal via Routes 25 and I-495 will be about 22 miles. Intermediate access to the highways is available at five interchanges: four in Wareham and one in Middleborough. Rochester is not served directly by limited-access highways, but Routes I-195 and I-495 and state Route 140 run through adjoining towns.

In addition to the I-495/Route 25 combination, the rail line to Bourne is followed closely by state Route 28 all the way from Middleborough to Buzzards Bay. This is an older, undivided highway, mostly two-lane, with unlimited access. It provides local collection and distribution for the newer routes.

Radial connections to the Buzzards Bay-Middleborough highways (or future rail service) are provided mostly by local roads. Exceptions are Route I-195 and U.S. Route 6, which both provide links to Wareham from the southwest, and state Route 58, which provides a connection from the north near the Wareham/Rochester border.

### ***Present Public Transportation Serving the Study Area***

Direct public transportation to Boston from the communities that would be in the service area of a Buzzards Bay commuter rail extension currently consists of express bus routes operated by private companies. Buses on each route serve a limited number of stops on the outer end, then run non-stop to Boston, making their final entry via the Southeast Expressway (I-93). Inbound A.M. peak and outbound P.M. peak trips use the high-occupancy-vehicle lane on the Expressway. All of the routes currently serve the new intercity bus terminal at

South Station. The same routes also provide direct service to Park Square, Logan Airport, or to both.

Bonanza Bus Lines operates two unsubsidized routes from the study area. The more heavily served of the two runs from Woods Hole and Falmouth, with intermediate stops in Bourne outside Otis Air Force Base and near the south end of the Bourne Bridge over the Cape Cod Canal. Counts from non-summer months in 1995 show 135 to 155 inbound A.M. peak passengers per day on this route, from all boarding locations combined.

The other Bonanza route runs from Buzzards Bay, with intermediate stops at the old railroad station site in downtown Wareham and at the Mill Pond Diner on Route 28 at Tihonet Road. Passenger counts from 1995 show that there are 55 to 65 inbound A.M. peak passengers per day on this route, including boardings at all stops.

The Plymouth & Brockton Street Railway Company operates a route to Boston from the Hyannis business district, with intermediate stops at park-and-ride lots at Routes 6 and 132 in Barnstable and at Sagamore Circle. Non-summer counts from 1995 show 500 to 510 inbound A.M. peak riders per weekday for this route. On summer days, this increased to about 530, reflecting commuting from summer homes. On most public transportation routes, ridership is lower in summer than in other months. The increase of 20 per day in the summer on the Hyannis route is the net result of reduced travel by permanent residents and added trips by summer residents and visitors, and therefore understates the number of summer-only riders. Some of the service on this route is subsidized the MBTA/EOTC Inter-District Transportation Service Program (IDTS) or the Cape Cod Regional Transportation Authority (CCRTA).

Further details about the bus routes serving the study area appear in Appendix A of this report.

The 1993 MBTA commuter rail survey, which provided a sample of 45 percent of the average inbound weekday riders throughout the system, included responses for only five trips beginning in towns in the service area of a Bourne extension. (One of these was for a trip repeated less than once a week.) Boardings for these trips were scattered among stations at Mansfield, Stoughton, Route 128, and Attleboro. The 1990 Census Journey-to-Work tabulations show a total of 23 work trips to Boston or Cambridge from the extension's service area by commuter rail. The Census results also show 37 work trips to Boston or Cambridge by rapid transit (presumably mostly via Braintree or Quincy Adams stations on the Red Line). All of these Census results are questionable, because they were expanded from very small samples.

Starting in September 1997, residents of the Bourne extension corridor will have access to the new Middleborough/Lakeville and Plymouth commuter rail lines,

both of which will have stations near exits from the major highways between southeastern Massachusetts and Boston. The demand forecasts for these lines indicate that they would attract about 165 inbound A.M. peak riders from the service area of a Bourne extension in the year 2000 if the extension were not built.

### **3. DESCRIPTION OF PROPOSED BOURNE COMMUTER RAIL SERVICE**

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#### **Alignment**

##### ***North of Middleborough***

The shortest rail route between Middleborough and Boston is the former Old Colony Railroad line via Brockton and Braintree, which is now being restored as the MBTA's Middleborough/Lakeville commuter rail line. (See Alignment and Stations map on page 10.) Analysis in Appendix B confirms that it would also be the fastest routing alternative between these points. Therefore, it is assumed to be the routing that would be used for Bourne service.

##### ***Middleborough to Buzzards Bay***

The Buzzards Bay Secondary Track is the only rail line connecting Middleborough with Buzzards Bay, and is the only through rail connection to Cape Cod from other points that has ever existed.<sup>2</sup> It follows a relatively direct alignment, with few speed restrictions resulting from curves, and does not bypass any substantial population centers within its corridor. Therefore, for purposes of this study no consideration is given to use of any other route south of Middleborough.

##### ***Beyond Buzzards Bay***

The demand analysis shows that the majority of riders on a Buzzards Bay extension would have trip origins south of the Cape Cod Canal. Therefore, an analysis of further extension of service on existing rail lines beyond Buzzards Bay is included in this report.

The Buzzards Bay Secondary Track connects at Buzzards Bay Station with the Hyannis Secondary Track. This line crosses the canal on a vertical lift-bridge immediately to the south of the station. It then turns and follows the south side of the canal to Sagamore, and continues through the towns of Sandwich and Barnstable to its terminus in the Hyannis business district. The total distance to Hyannis is 24.3 miles from Buzzards Bay, or 78.9 miles from South Station. This line passes under the south ends of the Bourne and Sagamore bridges at about 1.8 and 5.0 miles from Buzzards Bay Station.

The Falmouth Secondary Track diverges from the Hyannis Secondary at Canal Junction at the south end of the lift bridge, and continues south through Bourne

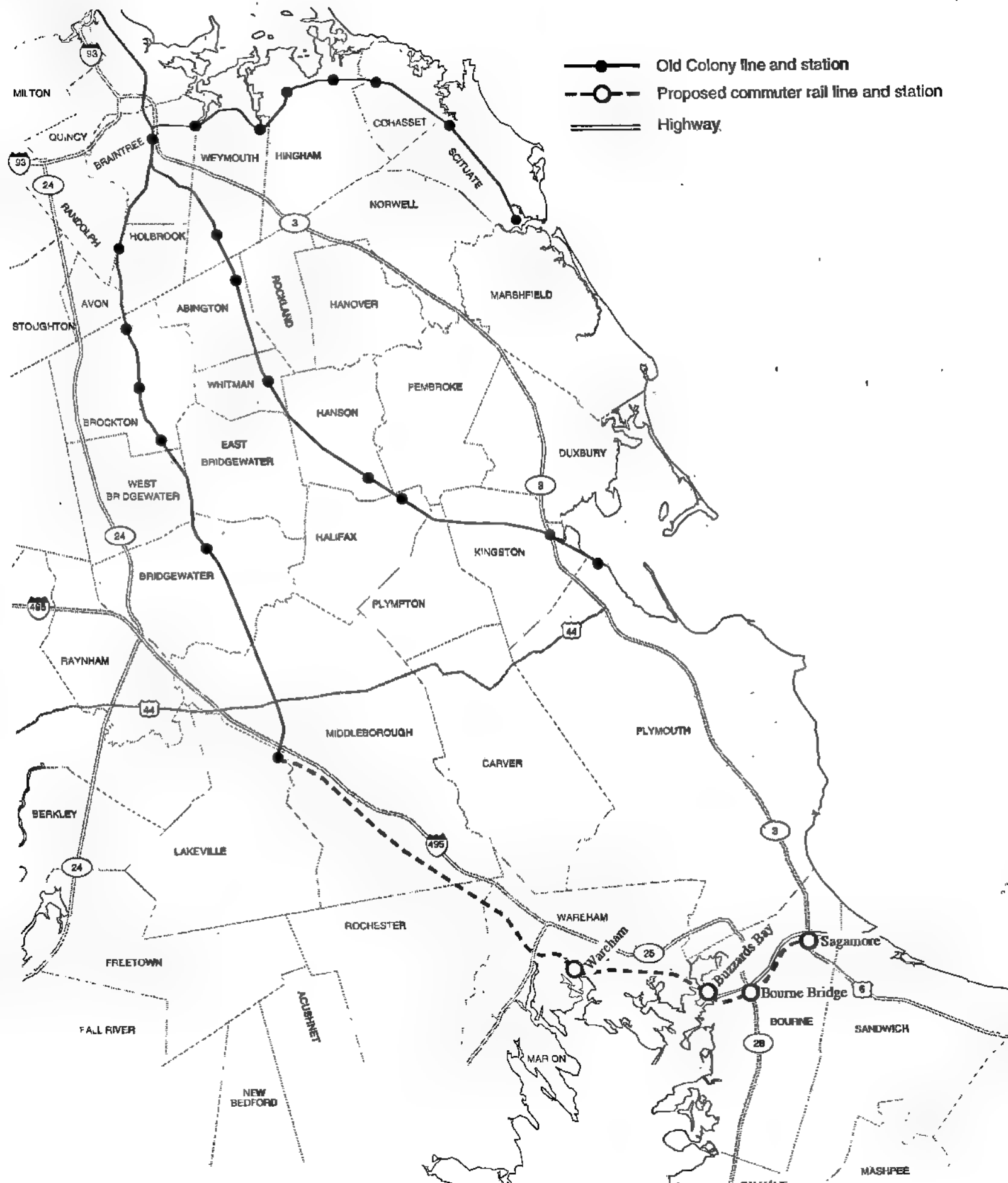
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<sup>2</sup>An extension of the Boston-Plymouth rail route from Plymouth to Cape Cod was proposed at various times in the past but was never built. Old maps showing the proposed extension or a short-lived street railway line in the same corridor have resulted in erroneous reports that such a rail line once existed.

# BOURNE COMMUTER RAIL

Feasibility Study

## ALIGNMENT AND STATIONS





to Falmouth. The total distance to Falmouth is 13.8 miles from Buzzards Bay, or 68.4 miles from Boston. (This line is currently in service only as far as North Falmouth, 6.7 miles from Buzzards Bay, where it connects with a spur track serving Otis Air Force Base.) A third branch divides from the Hyannis Secondary at Yarmouth Station, 21.2 miles from Buzzards Bay, and continues 5.6 miles further to South Dennis.

A commuter rail extension south of Buzzards Bay could use any of these lines. Prior to discontinuance of year-round passenger service from Boston in 1959, most Cape Cod passenger trains carried cars for both the Falmouth line (which then continued to Woods Hole) and the Hyannis line. Trains were split southbound and combined northbound at Buzzards Bay Station. The South Dennis line, which once continued to Provincetown, last had passenger service in 1940. Cars for this line were added to or dropped from Hyannis trains at Yarmouth.

With conventional locomotive-hauled trains such as those expected to be used on the Middleborough/Lakeville route, a minimum of five to ten minutes would be required to complete the switching moves needed to combine or separate trains for two lines, and to perform mandatory air-brake tests. This delay would make train service less competitive with other travel options. Running trains alternately to different branches would make service on either branch too infrequent to be attractive. Therefore, it is assumed that an extension beyond Buzzards Bay would use only one of the three possible routes.<sup>3</sup> The Hyannis line could provide direct service to more towns, with more demand for travel to Boston, than the Falmouth line could. It would also have the potential for direct interception of traffic heading to both the Bourne Bridge and the Sagamore Bridge. For these reasons, only an extension over the Hyannis line is analyzed in detail.

It should be noted that at 54.6 miles from South Station, a route to Buzzards Bay alone would be longer than any current MBTA commuter rail route. The longest route now is Boston to Fitchburg (49.6 miles), but the New Bedford route will be about 60 miles long.

### **Stations**

Identification of specific station locations is beyond the scope of this study, but for purposes of analysis some approximate station sites had to be assumed. (See Alignment and Stations map on page 10.) Buzzards Bay is specified as one station location in the legislation under which this study was performed. Because of the relatively short distance for which the rail line passes through

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<sup>3</sup>Operation of shuttle trains with cross-platform transfers at junction stations is another strategy that has been used in the past on the Cape Cod lines. This has not been examined in this report.

Buzzards Bay village, there is little choice for a station site there other than the traditional one. This is the site assumed in the analysis.

The distance of 19.1 miles between Middleborough/Lakeville and Buzzards Bay would be much greater than station spacing on any existing MBTA commuter rail segment except for Framingham to Worcester, and the long spacing there is only temporary. The demand analysis in Chapter 4 indicates that about one third of the ridership on the extension would originate in locations that would be best served by a station in Wareham. If there were no Wareham station, most of these riders would be unlikely to use a station at Buzzards Bay, because of inconvenient access. For these reasons, it is assumed that there would be a station in Wareham.

As detailed below, a Wareham station at the site currently used by Amtrak (and used by former commuter rail service) would have the least impact on running times from points further south of any site in Wareham. Because of limited land available for parking there, however, alternate sites would need to be considered.

Beyond Buzzards Bay, the most efficient strategy for serving riders would be to provide stations near the southern ends of the Bourne and Sagamore bridges. All highway traffic leaving Barnstable County (other than from the section of Bourne north of the canal) would have to pass within a short distance of one of these stations. Both station locations would be new. There is a substantial amount of vacant land east of the Bourne Bridge that appears to be suitable for a rail station. Siting a station near the Sagamore Bridge would probably require some relocation of existing commercial or industrial activity. The Canal Electric Company site, which begins about one mile east of the Sagamore Bridge, appears to be the most promising location for a station. If insufficient land for surface parking is available there, a multiple-story parking structure would not be inconsistent with the heights of the existing electric company structures.

Further analysis of station location alternatives is contained in Appendix C.

### **Layover Facility**

A layover facility for the trains on the Middleborough/Lakeville route is being constructed adjacent to the Middleborough/Lakeville station. Trains for Bourne service could be based at this location, but this would require operating a large amount of non-revenue train mileage at the beginning and end of each day. As discussed in Chapter 6, the cost of running these non-revenue trains would be \$2 million to \$3 million per year, depending on the outer terminal location. For an extension beyond Buzzards Bay, the non-revenue trains would also require more closings of the bridge over the canal, with increased disruption of marine traffic. For these reasons, a layover facility should be assumed to be included in a Bourne extension project.

With all Middleborough/Lakeville peak-period service running through from Bourne, the layover facility would require capacity for five train sets, each with one locomotive and up to ten double-deck cars. With parallel yard tracks, the minimum site size required would be about 1,000 feet long and 65 feet wide, or about 1.5 acres. It would be important to select a layover site that would not displace parking, because adequate parking capacity would be a critical factor in attracting ridership to a Bourne extension. If a site like the one just described (1.5 acres) displaced parking, over 200 parking spaces would be lost.

At Buzzards Bay there is little land available for parking in any case. Layover facilities could be provided within the right-of-way north of Buzzards Bay Station, which was formerly all double tracked, by parking trains end-to-end along the second track location. However, the line of trains would extend for nearly a mile. With an extension south of the canal, the optimal layover facility would be at the Canal Electric site. A possible site configuration there would have a parking structure built above layover tracks, in the manner of the new South Station garage.

### **Running Times**

As detailed in the following subsections, the travel time from Buzzards Bay to South Station via a Bourne commuter rail extension would be about 82 minutes. From Wareham (assuming use of the present Amtrak Station site) the time to South Station would be 75 minutes. An extension beyond Buzzards Bay to Sagamore would have additional running time of 11 minutes, making a total of 93 minutes to South Station. From an intermediate stop at the Bourne Bridge, the time to South Station would be 84 minutes.

#### ***Middleborough/Lakeville to South Station***

The analysis in Appendix B shows that the shortest and fastest routing between Middleborough/Lakeville Station and South Station for Bourne trains would be the restored Old Colony route, scheduled to open in September 1997. Because of track capacity constraints, all peak-period Bourne trains on this route would have to be run as extensions of trains that would operate between Boston and Middleborough/Lakeville anyway. Therefore, travel times north of Middleborough/Lakeville Station would be controlled by the local service requirements on that segment. For purposes of analysis, the 58 minute time shown in the Old Colony Rehabilitation Project EIR is assumed for peak-direction trips. (Operation of express trips, or establishment of additional stations would change this figure.)

#### ***Buzzards Bay to Middleborough/Lakeville***

The rail distance from the old Middleborough Station site to Buzzards Bay Station (still used for seasonal Amtrak service) was 20 miles. The new

Middleborough/Lakeville Station will be about 0.9 miles south of the former Middleborough Station site, or 19.1 miles from Buzzards Bay. For purposes of analysis, it is assumed that for commuter rail service to Bourne, signal and other improvements required to restore the line north of Buzzards Bay to its past maximum 79 m.p.h. speed limit would be implemented.

In the past, the track layout required speed limits lower than 79 m.p.h. on three short segments, all within the town of Wareham. The grade crossing of U.S. Route 6 east of Wareham Station had a limit of 15 m.p.h. for outbound trains and 40 m.p.h. for inbound. This was necessitated in part by sharp curves in both the highway and the rail line that limited visibility at the crossing, and which still exist. The proximity of this crossing to the Wareham and Agawam rivers and to the downtown Wareham business district would make a grade separation very costly, if not infeasible.

A curve in the railroad north of the Elm Street crossing required a 60 m.p.h. limit for a distance of about one half mile. Another curve between Route 6 and Indian Neck Road required a 40 m.p.h. speed for one third of a mile. All passenger trains on the line were scheduled to stop at Wareham Station, so the three speed restrictions had little practical impact on running times.

With an overall maximum speed limit of 79 m.p.h., no speed restrictions other than those listed above, and no intermediate stops, the fastest theoretical time from Middleborough/Lakeville Station to Buzzards Bay Station for a train of conventional commuter rail cars powered by a diesel locomotive would be about 17.5 minutes. Train schedules that require operation at the maximum allowable speed on each track segment provide no margin of error for making up time when delays occur. Therefore, it is standard practice to schedule running times somewhat longer than the theoretical minimums. Furthermore, the demand analysis in Chapter 4 and Appendix D indicates that the extension should include at least one station in Wareham. For these reasons the scheduled time from Buzzards Bay to Middleborough/Lakeville would exceed 17.5 minutes. A more probable time is discussed below.

### *Impact of Intermediate Stops on Running Times*

Compared to non-stop time, an intermediate station would increase running time by the length of the dwell time at the station plus the extra time required to decelerate to a stop and accelerate back to the maximum speed limit. Dwell times vary with the number of passengers boarding and alighting, the number of doors open, and platform configuration. At suburban commuter rail stations in peak hours, dwell times of around 45 seconds per stop are typical. The impact of acceleration and deceleration times increases with the speed that trains would otherwise be able to run in a given segment. For a standard diesel train, decelerating from 79 m.p.h. to a stop and returning to 79 m.p.h. requires about 1.9 minutes longer than traveling the same distance at a constant 79 m.p.h.

A station at the traditional Wareham site would have the least running time impact of any on the line, because trains have to slow down anyway for the crossings there. Such a station would add about 1.1 minutes of running time, or about 1.8 minutes including dwell time, regardless of the overall maximum speed limit on the line. This would result in a theoretical minimum time of 19.3 minutes from departure at Buzzards Bay to arrival at Middleborough/Lakeville. Allowing for variation in train performance and providing a margin for delays, a scheduled time of around 24 minutes from departure at Buzzards Bay to departure at Middleborough/Lakeville would be most probable.<sup>4</sup>

### ***Running Times South of Buzzards Bay***

Historically, the maximum speed limit on the rail line between Buzzards Bay and Hyannis was 59 m.p.h. (the maximum allowable speed without signals). There were restrictions of 40 m.p.h. in the vicinity of the Sandwich and Yarmouth stations and 30 m.p.h. in the vicinity of the West Barnstable station because of curves, grade crossings, and switches. A sharp curve at the south end of the lift bridge over the canal would also limit speed to about 40 m.p.h. under present safety standards. As on the line between Middleborough/Lakeville and Buzzards Bay, installation of a new signal system on the Hyannis line was begun in conjunction with the Amtrak service but was not completed.

In this report, the longest extension analyzed in detail is one to Sagamore, with stations in the vicinities of the Canal Electric complex and the Bourne Bridge. With track upgraded to the historic maximum limit of 59 m.p.h. on this segment, the running times from Buzzards Bay would be about three minutes to the Bourne Bridge and ten minutes to the Sagamore station. A non-stop run from Buzzards Bay to Sagamore would be about two minutes faster than a run with one stop at Bourne. These times would be attainable only if no delays were incurred for closing the lift bridge. Most of the alignment between the curve south of the lift bridge and Sagamore appears to be suitable for 79 m.p.h. operation, but for the distance involved, the time saving compared with a 59 m.p.h. limit would be only about one minute.

### ***Comparisons of Estimated Rail Times with Bus and Automobile Travel Times***

Current inbound A.M. peak scheduled bus times to South Station are 65 minutes from Wareham Station and 80 minutes from Buzzards Bay, compared with estimated train times of 75 and 82 minutes from the same locations. The scheduled running time to South Station from the Trowbridge Road bus stop in Bourne, (near the probable location of a Bourne Bridge commuter rail station)

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<sup>4</sup>For comparison, the fastest scheduled time from the old Middleborough Station site to Buzzards Bay in the 1950s was 24 minutes. This was for a single self-propelled diesel railcar making intermediate stops at Wareham Station and at Onset in off-peak hours.

varies from 65 to 70 minutes<sup>5</sup>. The estimated train time from a Bourne Bridge station is 86 minutes. Scheduled bus times from Sagamore Circle to South Station range from 70 to 80 minutes during most of the A.M. peak. The estimated train time from a Sagamore station is 93 minutes.

Based on these times, commuter rail service would be slower than bus service from all points on a Bourne extension. CTPS travel time runs suggest that peak-period congestion would typically add five to ten minutes to the published bus times from Wareham, Buzzards Bay, and Trowbridge Road, however. The Sagamore Bridge bus stop is on the north side of the canal, so access to it is subject to traffic delays on the bridge.

Table 3-1 summarizes comparative travel times from Wareham, Buzzards Bay, Bourne Bridge, and Sagamore to South Station for existing bus service and for a commuter rail extension with a top scheduled speed of 79 m.p.h. south of Middleborough/Lakeville.

The access times to most Boston destinations from South Station are slightly faster from the commuter rail platforms than from the bus terminal. The bus terminal is on air rights several stories above the south ends of the commuter rail platforms, requiring use of elevators or long escalators or stairways for access and egress. The walking time from the bus platforms to street level (by actual observation) is about 1.5 to 2.5 minutes depending on which gates the buses use. From the main bus station entrance on Atlantic Avenue, the walking distances

Table 3-1  
Comparison of Running Times to South Station  
from Wareham and Buzzards Bay  
for Rail Extension and Existing Bus Service

<u>Station</u>	<u>Commuter Rail Extension</u>	<u>Scheduled Bus Time</u>
Wareham	75 minutes	65 minutes
Buzzards Bay	82 minutes	80 minutes
Bourne Bridge	86 minutes	65-70 minutes
Sagamore	93 minutes	70-80 minutes

and times to destinations north of Summer Street or to the Red Line station are about the same as those from the midpoint of a commuter train on the South Station platforms.

<sup>5</sup>Scheduled times are faster from Trowbridge Road than from Buzzards Bay because the Trowbridge Road buses run non-stop to Boston entirely on limited-access highways. Buzzards Bay buses run on Route 28 to Wareham and make two stops in that town.



Most buses on the Sagamore Bridge route continue from South Station to Park Square, with an additional running time of 10 minutes. South Station would be the only downtown Boston location served directly by a Bourne commuter rail line.

Buses on all of the routes discussed above use the high-occupancy-vehicle lane on the Southeast Expressway. In 1990 single-occupant autos were used for 61% of the work trips to Boston or Cambridge from the Bourne extension corridor, but such vehicles cannot use the HOV lane. Two-person carpools, which accounted for another 11%, may be allowed in the HOV lane in the future. Only 5% of the trips were made in carpools of three or more persons that would definitely be allowed in the HOV lane. Travel time run results indicate that under average A.M. peak conditions, driving times to Kneeland Street in Boston for autos not using the HOV lanes would be about 83 minutes from either the Bourne Bridge or Sagamore Bridge. Additional time would be required for parking. Therefore, line-haul times for trains would compare more favorably with those for most auto trips than with those for buses.

### **Levels of Service**

The schedule assumed in the Final EIR for the Old Colony Railroad Rehabilitation Project has 14 round trips between Boston and Middleborough/Lakeville on weekdays, including five inbound A.M. peak trips. This is within the range of service levels currently operated on other MBTA commuter rail lines. Buzzards Bay and any stations beyond would be further from Boston than any stations in the present system. Fitchburg, which is about the same distance from Boston as Wareham, is served by ten round trips per day, including four inbound A.M. peak trips. Daily demand projected for a Bourne extension is substantially higher than that for current rail service from the Fitchburg area, however. Therefore, it is assumed for purposes of analysis that all Middleborough/Lakeville line trains would run through to Bourne.

The Old Colony EIR does not specify schedules for weekend service. At present, four of the five commuter rail lines operating into South Station have Saturday service, and three of these have Sunday service. On each of these lines, there are nine round trips on Saturdays and seven on Sundays. The demand analysis in Chapter 4 indicates that despite heavy weekend recreational travel to the Cape, especially in summer months, these would also be adequate levels of weekend service on a Bourne extension. Therefore, they are the levels assumed in the analysis.

### **Fares**

MBTA commuter rail lines have a zone fare system. Zone limits are based nominally on mileage from Boston, but some exceptions are made for reasons such as avoiding a difference in fares at two stations in the same town. On a

Bourne commuter rail extension, the traditional Buzzards Bay Station site would be 54.6 rail miles from Boston via the most direct route. This would place it in Zone 10. The one-way full fare from Buzzards Bay to Boston would then be \$5.50. As in other zones, a 12-ride ticket would be priced the same as 10 full fares, or \$55.00, making the cost per ride \$4.58. A monthly pass, which would allow unlimited riding and would include free transfers to all other MBTA services, would cost \$144.00. The 1993 commuter rail survey results show that passes are used for an average of about 42 trips per month. This would result in an average cost of \$3.43 per ride for a Zone 10 pass.

The Zone 10 half-fare for senior citizens, children under age 12, pupils through high school traveling to or from school, and persons with disabilities would be \$2.75. There are no half-fare 12-ride tickets or monthly passes. Ten-ride half-fare tickets are available but are priced the same as ten individual tickets.

The traditional Wareham Station site would be 49.3 rail miles from Boston via the most direct route, and would be in Zone 9. Any other potential station sites in the town of Wareham but closer to Boston would also fall within the usual limits of Zone 9. A station at Onset would be 51.4 rail miles from Boston. This would place it in Zone 10, the same as Buzzards Bay, but if there were also a stop at Wareham Station, current practice would put Onset in Zone 9 for consistency.

The current Zone 9 one-way full fare is \$4.75. Twelve-ride tickets are \$47.50, making an average cost of \$3.96 per trip. Monthly passes are \$136.00, resulting in a cost of \$3.24 per trip if used 42 times. The half fare is \$2.35.

Because of the limited precedent for stations further from Boston than Zone 9, it is unclear how fares would be set on an extension beyond Buzzards Bay. If it is assumed that the limit of Zone 10 would extend to 60 miles, a Bourne Bridge station would be in Zone 10. A Sagamore station would be on the border of Zones 10 and 11 but would probably be placed in Zone 10 for consistency with Bourne Bridge. Therefore, both stations would have the same fares described above for Buzzards Bay.

The private-carrier bus companies operating service between Boston and Cape Cod points offer a choice of one-way, round trip, and ten-ride tickets, all valid for 30 days from the date of purchase. As of April 1996, the Bonanza Bus Lines one-way fare from Boston was \$8.00 to either Wareham or Buzzards Bay. There was no discount on the round-trip fare. The fare to the Trowbridge Road stop in Bourne was \$9.50 one way and \$17.00 round trip. Ten-ride tickets to any of these points were \$47.00, resulting in an average cost of \$4.70 per trip. Excluding half-fares, the rail fares estimated above would range from \$3.24 to \$4.75 at Wareham, and from \$3.43 to \$5.50 at Buzzards Bay.

On the Plymouth & Brockton Street Railway bus service to Cape Cod, the present fare from Boston is \$11.00 one way or \$20.00 round trip to Sagamore, Barnstable,

or Hyannis. At Sagamore, the closest stop to Buzzards Bay, the ten-ride fare is \$45.00, resulting in a one-way fare of \$4.50.

Bonanza and Plymouth & Brockton both charge half the one-way full fare for children ages 5 through 11, when accompanied by an adult, but do not have reduced fares for the other categories of riders eligible for commuter rail half-fares. Half-fare passengers in all categories currently account for less than 4% of weekday commuter rail ridership, based on ticket sales reports and survey data, however.

Table 3-2 summarizes one-way trip costs for existing bus service and potential rail service under the various fare options described above. At present, most MBTA commuter rail parking lots have fees of \$1.00 per day in addition to the train fares. Free parking is available at or near most of the express bus stops.

Table 3-2  
Cost per One-Way Trip to Boston for Selected Bus and Rail Fare Options

<u>Station</u>	<u>One- Way Bus</u>	<u>Round Trip Bus</u>	<u>10-Ride Bus</u>	<u>One- Way Rail</u>	<u>12-ride Rail</u>	<u>Monthly Rail Pass</u>
Wareham	\$8.00	\$8.00	\$4.70	\$4.75	\$3.96	\$3.24
Buzzards Bay	\$8.00	\$8.00	\$4.70	\$5.50	\$4.58	\$3.43
Bourne Bridge	\$9.50	\$8.50	\$4.70	\$5.50	\$4.58	\$3.43
Sagamore	\$11.00	\$10.00	\$4.50	\$5.50	\$4.58	\$3.43



## 4. RIDERSHIP FORECASTS

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### Potential Commuter Rail Market Groups

#### *Boston and Cambridge Work Trips*

On the commuter rail lines now terminating at South Station, 95% of all final trip destinations are in either Boston or Cambridge, and 89% of these are home-to-work trips. Otherwise stated, home-to-work trips ending in these two cities account for 85% of all South Side commuter rail ridership. Over 95% of the home-to-work trips on South Side commuter rail lines are made on A.M. peak trains, defined as those scheduled to arrive at South Station between 6:30 and 9:30. Existing travel patterns in the corridor that would be served by a Bourne extension indicate that work trips to Boston and Cambridge would likewise be the predominant source of weekday ridership on such a line.

Within Boston, the commuter rail market share is highest for trips ending in Boston Proper, defined approximately as the area bounded by Massachusetts Avenue, the Charles River, Boston Harbor, Fort Point Channel, and the Southeast Expressway. The 1993 commuter rail survey found that 90% of the Boston work trip destinations on South Side commuter rail lines were in Boston Proper. In contrast, 1990 Census figures showed that only about 55% of *total* Boston work trip destinations (all modes of travel) from the cities and towns served directly or indirectly by these rail lines were in Boston Proper. Rail work trip destinations to Boston locations outside Boston Proper were concentrated most heavily in neighborhoods bordering on Boston Proper, with 92% going either to the Fenway/Parker Hill area, South Boston, Charlestown, or North Dorchester. There is sufficient variation among towns in the split of Boston Proper/Boston Other work trip destinations to require separate analysis of these two sub-markets in the Bourne extension demand forecasts.

#### *Other Destinations and Trip Purposes*

Work trips account for a much higher proportion of commuter rail trips destined for Boston or Cambridge than of those destined for other locations. In the survey results, of the 5% of South Side rail trips with destinations outside Boston or Cambridge, only 40% (or 2% of the total ridership) were work trips.

Among South Side rail trips with destinations outside Boston or Cambridge, the vast majority involve traveling into Boston and transferring from commuter rail to other modes. Interzone ridership (i.e., trips between two stations on the same line excluding South Station, Back Bay, or stations in fare zone 1A or 1B) accounts for under 1% of weekday trips. This may, however, be more a reflection of the locations of rail stations relative to suburban trip attractions than of inherent unattractiveness of commuter rail for suburb-to-suburb travel. On North Side lines, interzone travel accounts for 4.4% of all trips, with higher proportions on

the two longest routes. Rather than simply applying factors for interzone travel from the Bourne extension corridor, an attempt has been made to identify interzone travel markets specific to the Bourne extension, and to estimate the potential rail share of these markets. Interzone non-work trips on existing lines are mainly school or shopping trips. These are typically made over much shorter distances than would be possible for interzone trips from a Bourne extension, however. Therefore the demand estimate for interzone trips on the extension is based mostly on work trips.

### ***Weekend Ridership to and from Cape Cod***

Because of recreational travel, the heaviest total traffic volumes to and from Cape Cod occur on summer weekend days. For reasons discussed below, however, the share of such travel that would be captured by a commuter rail extension to Bourne would be relatively small. Therefore, although a detailed analysis of weekend ridership has not been done for this study, the findings of such an analysis would be likely to have little impact on a decision on implementation of rail service.

None of the three station locations in Bourne would be within convenient walking distance of public beaches, which are one of the main attractions for one-day or weekend visitors. The trains would also not provide access to ferries to Martha's Vineyard and Nantucket, which are another large source of weekend travel. Bus connections from the trains to the beaches and ferries could be provided, but service capable of accommodating large numbers of riders would be costly to operate. It is unlikely that owners of second homes on the Cape would leave cars parked at the rail stations all week while commuting to work from their primary residences.

At the opposite trip end, much of the summer weekend travel to the Cape originates at points that would not be served conveniently by a rail line from Boston. A 1979 study prepared for the MBTA<sup>6</sup> concluded that at least 75% of the summer weekend travel to the Cape originated elsewhere than Greater Boston. The largest source of summer weekend trips, at 40% or more, was found to be the South Shore. These trips were not broken down by town of origin, but presumably many of them came from towns other than those along the route of a Boston to Bourne train. The South Shore highway network is not conducive to long radial trips to access rail stations.

The private-carrier bus lines serving the Cape provide direct service to many more destinations than the rail service would, including the ferry terminals at Hyannis and Woods Hole. Nevertheless, the scheduling practices of the bus lines indicate that their ridership is significantly lower on weekends than on

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<sup>6</sup> Urban Transportation Systems Associates, Inc. *A Study of the Summer Recreational Demand for Rail Service from Boston to Cape Cod*. May 1979.

weekdays even in the summer. The Plymouth & Brockton Street Railway Company schedules slightly over half as many trips on their Hyannis line on weekends as on weekdays. On the Bonanza Bus Lines Falmouth/Woods Hole route, non-summer service is reduced 20% on Saturdays and 25% on Sundays compared with weekdays. The weekday service level is only 40% of that on the Hyannis line, however, so there is less margin for weekend service reduction. Summer Saturday service on this route is the same as weekday service. Slightly more service is run on Sundays than weekdays, but this is mainly a consequence of the connecting ferry schedules.

### **Summary of Demand Estimation Method**

The service area of a Bourne extension would be outside the boundaries of the CTPS regional demand model, so a manual forecasting method was used. Total work travel from each town in the extension corridor to each Boston and Cambridge neighborhood was determined from the 1990 U.S. Census Journey-to-Work reports. Estimates of minimum and maximum shares of this travel that a commuter rail extension could be expected to capture were made on the basis of information for existing commuter rail lines in the Census reports and in the 1993 MBTA commuter rail survey. The average of the maximum and minimum values was assumed to represent the most likely ridership level. Interzone ridership was estimated from Census data on work trips from the extension corridor to destinations within walking distance of stations on the Middleborough/Lakeville line. Factors were added to the Boston, Cambridge, and interzone work trip estimates to allow for ridership to other destinations and for non-work trips. The 1990 results were updated to 1996 using a combination of data from the Census Bureau, the Metropolitan Area Planning Council, and the Massachusetts Institute of Social and Economic Research. Similar procedures were used to project ridership for the years 2010 and 2020. Further details of the demand estimation method are described in Appendix D.

### **Ridership Forecasts by Trip Purpose and Destination**

Based on the ridership forecasting methods discussed above and in Appendix D, if a Bourne extension were in operation in 1996, it would carry about 1,200 riders in each direction on non-summer weekdays. Of these riders, about 1,115 would have destinations in Boston or Cambridge. Of the remainder, about 65 would have destinations in intermediate cities and towns between Cape Cod and Boston. Trips through Boston to points not on the Middleborough/Lakeville commuter rail line would account for an estimated 20 riders a day. The primary trip purpose would be commuting from home to work. This would account for about 1,025 of the 1,200 trips. Population and employment projections indicate that ridership would change little in future years, increasing to about 1,265 in the year 2010 and to about 1,305 in the year 2020.

### Estimated Ridership by Town of Origin

Table 4-1 shows the 1996 demand estimates by town of origin. Estimates for the years 2010 and 2020 are not shown, because population growth projections for these years are not subdivided below the planning district level.

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Table 4-1  
1996 Estimated Weekday Inbound Ridership on Bourne Extension  
by Town of Origin

<u>Town</u>	<u>Trip Origins</u>
Wareham	270
Rochester	50
Marion	30
Mattapoisett	30
Bourne	120
Falmouth	145
Sandwich	175
Mashpee	90
Barnstable	215
Yarmouth	40
Dennis	20
Rest of Cape Cod	<u>15</u>
Total	1,200

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### Estimated Diversions of Ridership from Other Transit Services

At present, very few trips originating in towns that would be served by a Bourne extension are made by MBTA transit services. Expanded results from the 1993 commuter rail survey put the total by that mode at under 15 trips per day, and Census figures indicate that the total is no more than 30. Census figures show 44 work trips by rapid transit from the Bourne extension service area, presumably mostly via the Red Line. The opening of the Old Colony Middleborough/Lakeville and Plymouth lines in 1997 will bring MBTA service much closer to the Bourne extension corridor, however. Travelers from the Bourne extension service area who use existing commuter rail or rapid transit stations will be likely to divert to Old Colony stations, so they would be included in the forecasts for that line.

The demand forecasts in the Old Colony EIR show A.M. peak ridership for the year 2000 only. Breakdowns by origin location are contained in the EIR volume entitled "Methods and Results Report: Service and Patronage Impact Assessment," dated October 1989. Origins from Wareham, Rochester, Marion, and Mattapoisett are shown by individual town. Origins from Barnstable



County are consolidated into four groups: CC/Canal, CC/Inner, CC/Mid, and CC/Outer.<sup>7</sup>

The EIR figures indicate that the only Old Colony stations that will serve trips originating in towns in the Bourne extension market area will be Middleborough/Lakeville and Kingston. Middleborough/Lakeville is expected to serve only 7 inbound A.M. peak trips from Wareham, Marion, and Mattapoisett combined, and none from Rochester or from towns in Barnstable County. Kingston Station will serve 158 A.M. peak trips from Barnstable County and 1 from Wareham, but none from the other towns in the extension corridor.

Assuming that A.M. peak ridership will be about 85% of the all-day total (as it is on existing South Side commuter rail lines), the numbers above would expand to 195. The population and employment projections used in the forecasts for the Bourne extension indicate that the change in this number between the years 1996 and 2000 would be insignificant. Stations in Wareham or Bourne would be much closer to the outer ends of these trips, so with unconstrained parking, all of these riders would be likely to divert to stations on a Bourne extension.

At present, the primary transit mode for residents of the Bourne extension corridor is private-carrier bus. Passenger counts taken in conjunction with the Southeast Expressway HOV lane implementation show that an average of about 710 passengers currently ride weekday inbound A.M. peak buses on routes to Boston from Barnstable County and Wareham. In other corridors where commuter rail service has been implemented in competition with established bus service, 30% to 50% of bus riders have been diverted to rail. A 40% diversion of the 710 Bourne extension corridor peak-period bus riders would be 285. Off-peak bus ridership counts are not readily available. Assuming that peak and off-peak diversions would be in similar proportion to peak and off-peak rail ridership, there would be about 50 off-peak diversions, making a total of 335 inbound diversions.

Subtracting the 195 commuter rail diversions and 335 bus diversions from the estimated total of 1,200 riders on a Bourne extension leaves 670 new transit users. The 335 bus diversions, may, however, include some riders who will shift to the Middleborough/Lakeville or Plymouth commuter rail lines if there is no Bourne extension. Such riders would already be counted in the 195 commuter rail diversions.

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<sup>7</sup>The boundaries of the four Cape Cod groups are not clearly defined in the EIR. Based on the number of Journey-to-Work trips shown for each group, they are apparently constituted as follows: Canal - Bourne and Falmouth; Inner - Sandwich and Mashpee; Middle - Barnstable and Yarmouth; Outer - remainder of Barnstable County.



## 5. CAPITAL COSTS

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The main capital costs for commuter rail extensions generally consist of construction or upgrading of tracks, signals, bridges, and crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. A Bourne extension would operate entirely over single-track lines which were rebuilt in 1986 in conjunction with the startup of Amtrak summer service. Some additional investment is needed to bring these lines up to commuter rail system standards, however.

The present track consists of 110-pound welded rail on stone ballast. No major problems of rail alignment or surface are evident. Installation of new wayside automatic block signals was begun as part of the 1986 project. Signal masts and heads are in place, but final wiring was never completed because present train speeds and traffic levels do not require signals. The present Amtrak service does not include stations at all of the locations most desirable for commuter service, and the stations that are appropriately sited lack full high-level platforms. They also have very limited parking capacity. The Amtrak trains are stored from Friday night to Sunday afternoon in a yard north of Hyannis Station. This site is too small and too far removed from the probable endpoint of a Bourne extension to be used as the layover point for that service. The capital requirements for a Bourne extension are discussed below in more detail.

### Track and Signals

A Bourne extension would be dissimilar to many commuter rail extensions examined by the MBTA in that extensive upgrading for passenger service on the route was done only 10 years ago. More detailed engineering studies than were possible within the scope of this study would be needed to refine the cost estimates given here for further upgrading now required.

The Federal Railroad Administration (FRA) sets forth safety standards for determining the maximum speed limit allowed on a given section of railroad track. The 1986 upgrading of the Buzzards Bay Secondary Track placed it in FRA Class 3. This would allow a maximum speed of 60 m.p.h. with working signals, or 59 m.p.h. without signals. Present MBTA policy calls for Class 4 track, which would allow a top speed of 79 m.p.h. with wayside signals only, or 80 m.p.h. with cab signals. One of the main differences between Class 3 and Class 4 is the minimum number of non-defective crossties required in a given length of rail. Depending on the extent to which Class 3 tie standards are already exceeded, up to 550 ties per mile may need to be replaced between Middleborough/Lakeville and Buzzards Bay. The total cost of this work would range up to \$1.1 million.

Another change required for higher speed limits is increased elevation of the outside rail on curves. Between the Middleborough/Lakeville station site and

Buzzards Bay there are nine curves that would limit speed to under 80 m.p.h. with no rail elevation. Of these, six are 1° curves that would require only 1.5" of rail elevation, but three would require more substantial changes. The sharpest of these curves is one of 2°30' at Elm Street in Wareham. Historically, this curve had a 60 m.p.h. limit. With a 6" rail elevation, the maximum permitted by the FRA, the top speed there would be 72 m.p.h. This amount of elevation could, however, cause problems for slower-moving freight trains on the line and would also be difficult to provide without creating a hazard at the Elm Street crossing. Therefore, a compromise of 3.5" of elevation with a 60 m.p.h. limit is assumed.

A curve of 1°42' centered on the Route 6 crossing in Wareham would limit the speed with no rail elevation to 50 m.p.h. Because of the grade crossing, the feasible elevation of the rail there would be limited to less than the 5" required for a 79 m.p.h. speed. For safety reasons, the speed at this crossing was historically limited to 15 m.p.h., which had little impact on running times of trains stopping at Wareham Station. The total cost of elevating rail on all curves between Middleborough/Lakeville and Buzzards Bay to provide the maximum feasible speed limit up to 79 m.p.h. would be about \$300,000.

The track between Buzzards Bay and Sagamore has had less extensive upgrading. Summer Amtrak trains currently average about 30 m.p.h. on this segment, compared to a historical speed limit of 59 m.p.h. If the Bourne extension is to terminate at Sagamore rather than Buzzards Bay, an allowance of \$1 million should be included for upgrading the track south of the canal.

At present, there is one passing track between Middleborough/Lakeville and Buzzards Bay, at about the midpoint between them. It is currently out of service, but it was rebuilt in 1986 and does not appear to require any substantial upgrading. The switches at the ends of the siding are equipped for remote operation, which would be consistent with the requirements of commuter train service.

Most of the hardware for a wayside signal system is in place on the extension route, but final wiring is needed at undetermined cost. Installation of a cab-signaling system, as is currently planned for the other Old Colony lines, would cost an estimated \$2 million additional.

### Cape Cod Canal Bridge

An extension south of Buzzards Bay would require trains to cross the Cape Cod Canal on the existing vertical-lift bridge. This bridge, which was built in 1935, is owned and maintained by the U.S. Army Corps of Engineers. It is normally kept in the raised position, being closed only for passage of trains. A commuter rail extension to Sagamore would require much more frequent raising and lowering of the bridge than has occurred in recent years. Some upgrading of the draw mechanism may be needed to ensure swift and reliable operation. Such

upgrading would apparently be the responsibility of the Corps of Engineers rather than the MBTA, however.

The present track condition on the bridge requires a speed limit of 10 m.p.h., compared to a historical limit of 59 m.p.h. (Because of the location of Buzzards Bay Station north of the bridge and a sharp curve south of the bridge, the maximum attainable speed on the bridge would be under 40 m.p.h. regardless of condition.) Rail and tie replacement on the bridge could only be done when it is closed. This would require numerous short work sessions to avoid interference with marine traffic. Allowing for the resulting inefficiency in labor, the estimated cost would be about \$250,000.

### **Road Crossings**

Most of the grade crossings of public roads between Middleborough/Lakeville and Buzzards Bay have asphalt surfaces with timbers on each side of each rail. These surfaces are in only fair condition, but appear adequate for the present levels of road traffic. These crossings should be rebuilt for 79 m.p.h. rail service, however. The total expense for this would be about \$350,000. Lights and gates at all crossings are relatively new and are in working order. For 79 m.p.h. service, the track circuits activating the crossing protection would need to be lengthened, but this would entail a minor expense. There are no public grade crossings between Buzzards Bay and Sagamore.

### **Fencing**

At present, none of the right-of-way between Middleborough/Lakeville and Sagamore is fenced in, except where abutting property owners have installed their own fences. At grade crossings, gates have been placed across the former second-track location to prevent entry of unauthorized vehicles, but trespassing by pedestrians and dirt-bikers still occurs. For safety, the right-of-way should be fenced wherever developed land abuts the tracks. A preliminary investigation indicates that between Middleborough/Lakeville and Buzzards Bay segments totaling about ten miles should be fenced, at a cost of \$700,000. South of the canal an additional three miles should be fenced, at a cost of \$210,000.

### **Station Platforms and Shelters**

The operating plan for the Old Colony lines calls for limited personnel on board trains. Stations will have high-level platforms, and coach doors will be opened and closed remotely from a central location on each train. For compatibility with this, stations on a Bourne extension would also require high-level platforms.

The existing Buzzards Bay Station has a long, paved low-level platform in good condition and a mini high platform similar to those recently installed at many locations on the present commuter rail system. If Buzzards Bay were the outer

terminal of a Bourne extension, a full-length high-level platform would be required there. With a further extension to Sagamore, however, no more than 15 passengers would board or alight from any individual train at Buzzards Bay. Such volumes could be accommodated with no delays by requiring all passengers to use the mini high-level platform there.

At the present Wareham Station site used by Amtrak, most of the platform is in need of reconstruction, and there are no access facilities for persons with disabilities. For commuter service, a full-length high-level platform would be needed.

A contract recently awarded for construction of high-level platforms, shelters, and benches on the Plymouth and Middleborough/Lakeville Old Colony branches has a cost of \$11.25 million for 14 stations. This is an average of \$804,000 per station. Most of these will be built at sites where there have not been stations previously. Stations at the Bourne Bridge and Sagamore and at sites in Wareham other than the present Amtrak station could be expected to have similar costs for the same items. Real estate acquisition costs would be in addition to these and would be site-specific. Replacement of the platforms at the Buzzards Bay and Wareham Amtrak stations with high-level platforms should cost less than the \$804,000 each at locations requiring initial site preparation.

### **Parking**

The present Wareham Station has 69 commuter parking spaces, of which about 40 are currently vacant on a non-summer weekday and 25 to 30 on a summer weekday. With demand as forecast in Chapter 4 and allowing for walk-ins and drop-offs, a station in Wareham would require about 315 parking spaces to accommodate peak demand, which would occur in the summer. The present station site has little room for expansion of parking beyond that currently provided without construction of a multi-level parking structure.

The present Buzzards Bay station site has parking capacity for 100 to 150 cars including paved and unpaved lots. Most of these spaces are unused in non-summer months, but are filled by visitors to the downtown shops and the recreational area along the canal in the summer. The demand estimates for a commuter rail extension indicate that at current travel levels about 690 parking spaces would be needed at stations in Bourne in summer months. Because of limited available land at any one site, it would probably be necessary to divide boardings among two or more stations.

For purposes of analysis, it is assumed that a Bourne Bridge station would not be provided unless there were also a Sagamore station, but that a Sagamore station could be provided either with or without a Bourne Bridge station. With stations in operation at both of these sites, fewer than 50 passengers a day would choose to board at Buzzards Bay, and the majority of these would walk to the station or

be dropped off. Therefore, no substantial investment in permanent parking facilities at Buzzards Bay should be made if a further extension with the two other stations in Bourne is planned. With stations at Buzzards Bay and Sagamore but not at the Bourne Bridge, the Buzzards Bay station would need about 175 parking spaces for rail passengers.

The stations at Bourne Bridge and Sagamore would have very limited walk-in potential because of low population densities in their immediate vicinities. At present travel levels, a Bourne Bridge station would need about 175 parking spaces if there were also a Buzzards Bay station. If there were no Buzzards Bay station, passengers who would prefer a station there would be more likely to divert to Wareham than to the Bourne Bridge station, because use of the latter would require backtracking and crossing the bridge. Therefore, elimination of the Buzzards Bay station would increase parking requirements at a Bourne Bridge station by fewer than 20 spaces.

At current travel levels, a Sagamore station would need about 515 parking spaces in summer months, regardless of whether or not there was a Bourne Bridge station. About 75% of the ridership at a Sagamore station would come from points to the east that could be served more directly by a further extension of service along the Hyannis rail line. If implementation of service as far as Sagamore is found to be operationally feasible as well as desirable from a ridership standpoint, but sufficient parking capacity cannot be provided there, a further extension may then be a solution. The further east the terminal was, the more likely ridership from towns east of Bourne would be to approach the upper-bound estimates discussed in Appendix A. Compared with the estimates in Table 4-1, this would mean an increase of at most 225 inbound riders, but capital and operating costs would also increase in proportion to the added distance.

Combining the results given above for individual stations, a Bourne extension would require construction of a total of about 975 new parking spaces to meet summer demand. The average cost of constructing surface parking lots at commuter rail stations is about \$3,000 per space. At this rate, parking facilities on a Bourne extension would cost \$2,925,000. Because of limited site sizes, at least some of the parking might have to be in structures rather than in surface lots. The cost for structured parking is about \$15,000 per space. With all parking being in structures, the cost would be \$14,625,000.

### **Layover Facility**

As discussed in Chapter 3, a Bourne extension should include an overnight layover facility for trains somewhere near the outer terminal to minimize expenses of non-revenue train operation. The cost of a facility with sufficient capacity for all trains on the Middleborough/Lakeville route would be about \$2 million. (The operating cost savings compared to Bourne service with trains

based at Middleborough/Lakeville would exceed the cost of such a layover facility in less than a year.)

### **Rolling Stock**

Commuter rail service to Bourne would be operated by extending trains that would otherwise run to Middleborough/Lakeville Station, but the additional ridership from stations on the extension would require more cars per train. In the tentative schedule for the Middleborough/Lakeville line, the greatest number of train sets would be required in the A.M. peak, when there would be five trips. These would be provided by four train sets, with the first and fifth peak trip being made by the same set. The longer running time between Bourne and Boston would make it impossible for any train set to cover more than one inbound A.M. peak trip over the full route. Therefore, if all service were extended to Bourne, a fifth train set would be required.

About 85% of the inbound daily ridership on a Bourne extension could be expected to occur in the A.M. peak. At 1996 travel levels, this would be about 970 through trips to Boston. The impact of this on train lengths would depend on how this demand was distributed among trains, and on how much excess capacity these trains would have without the extension ridership. On the existing South Side commuter rail lines, loads vary greatly among individual peak trips on each route. For lines with five peak trips, the most heavily used trip carries as much as 33% of the peak ridership, and the least patronized trip carries as little as 8%. Assuming that train lengths would be sufficient to provide seats for all riders, and that additional capacity for extension riders would be provided by adding double-deck cars with seating capacities of 185 each, a total of five cars would need to be added to the first four A.M. peak trains, and the additional set would need a locomotive and five cars.

Currently locomotives cost about \$2.2 million each and double-deck coaches about \$1.6 million each. For the rolling stock requirement specified above, the cost would be \$18.2 million.

### **Summary of Capital Costs**

The capital costs discussed above for Bourne extensions terminating at Buzzards Bay or at Sagamore would be as shown in Table 5-1.

If site constraints were to make it necessary to use structured parking, this could increase the project cost by up to \$13 million. Excluding parking facilities, an extension terminating at Buzzards Bay would cost about \$3 million less than an extension to Sagamore. A Buzzards Bay terminal would be more likely to require structured parking because of the more limited site availability north of the canal, however. It should be emphasized that these are approximate cost



figures, and that more detailed engineering studies would be required to refine them.

Table 5-1  
Summary of Capital Costs for Bourne Extension

	<u>Middleborough to Buzzards Bay</u>	<u>Buzzards Bay to Sagamore</u>	<u>Total</u>
Track and Signals	\$3,000,000	\$1,400,000	\$4,400,000
Track Work on Lift Bridge	0	250,000	250,000
Resurfacing Road Crossings	350,000	0	350,000
Right-of-Way Fencing	700,000	210,000	910,000
Station Platforms and Shelters	1,608,000	804,000	2,412,000
		(see note)	
Parking (assuming surface lots)	2,925,000	(see note)	2,925,000
Layover Facility	2,000,000	(see note)	2,000,000
10% Contingency Factor	1,058,000	267,000	1,325,000
Rolling Stock	<u>18,200,000</u>	<u>0</u>	<u>18,200,000</u>
Total	\$29,841,000	\$2,931,000	\$32,772,000

Notes: Station Platform and Shelter costs assume that with a Sagamore terminal, no improvements at the existing Buzzards Bay Station would be needed because of the low remaining ridership there.

The total number of parking spaces would be the same with either terminal, the only difference being their location. Therefore, a Sagamore extension would not increase parking cost compared with a Buzzards Bay terminal.

There would be one layover facility, located near the outer terminal.



## 6. OPERATING COSTS AND REVENUES

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### Operating Costs

As discussed in other chapters of this report, commuter rail service between Bourne and Boston would be operated by extending trains that would otherwise run between Middleborough/Lakeville Station and Boston. Therefore, the operating cost for the Bourne service is calculated below as the difference between operating to Bourne and operating to Middleborough/Lakeville only.

The components of operating costs for commuter rail include train crew wages and benefits, fuel, maintenance of equipment, maintenance of fixed facilities such as tracks, signals, and stations, and administrative costs. A precise calculation of these costs for a Bourne extension would require more specific information on schedules, train lengths, and crew assignments than can be determined at this time. For studies such as this one, the MBTA Planning Department estimates costs using the average cost per train-mile for the most recent year available. The latest figure is from fiscal year 1994, during which the unit cost was \$39.50 per train-mile.

The distance from Middleborough/Lakeville Station to Buzzards Bay Station is 19.1 miles. The additional distance from Buzzards Bay to a terminal near the Sagamore Bridge would be about 5.4 miles, for a total distance of 24.5 miles from Middleborough/Lakeville. The schedule assumed in the Final EIR for the Old Colony Railroad Rehabilitation Project has 14 round trips between Boston and Middleborough/Lakeville on weekdays. Extension of all of these trips through to Buzzards Bay would increase weekday train-miles by 534.8. A Sagamore extension would raise this figure to 686.0.

In addition to costs of revenue service, train-mile expenses would be incurred for moving equipment between the outer terminal and a layover facility. With no extension beyond Middleborough/Lakeville, trains would be based at a new facility near the station there, so little non-revenue mileage would be incurred. At a Buzzards Bay terminal, because of limited space and the need to provide substantial parking capacity, provision of a nearby layover facility might prove to be infeasible. There would be fewer constraints on placing a layover facility near a Sagamore terminal, but further investigation would be required to determine if this could be done. The most costly scenarios would involve keeping train sets overnight at Middleborough/Lakeville and making non-revenue trips to position equipment in Bourne before the A.M. peak and return it to the yard at night. (The operation of several existing MBTA commuter rail routes includes non-revenue trips of lengths similar to that from Middleborough/Lakeville to Buzzards Bay or Sagamore.)

Extension of all 14 Middleborough/Lakeville round trips to Buzzards Bay or Sagamore would require the use of five train sets. With each of these making one

non-revenue round trip between Middleborough/Lakeville and the outer terminal, non-revenue mileage would total 191 per weekday with a Buzzards Bay terminal and 245 with a Sagamore terminal. Combined with the added revenue mileage, this would make totals of 725.8 and 931.0 added train-miles for the two terminal options.

Compared with service terminating at Middleborough/Lakeville, at \$39.50 per train-mile the extra operating cost for service to a Buzzards Bay terminal with no non-revenue trips would be \$21,125 per weekday. With a Buzzards Bay terminal and equipment based at Middleborough this cost would be \$28,670 per weekday. The cost with a Sagamore terminal and no non-revenue miles would be \$27,100 per day. The cost with a Sagamore terminal and equipment based at Middleborough would be \$36,775.

The Old Colony EIR does not specify schedules for weekend service. At present, four of the five commuter rail lines operating into South Station have Saturday service, and three of these have Sunday service. On each of these lines, there are nine round trips on Saturdays and seven on Sundays. Headways range from about 1.5 to 2.5 hours. With a two-hour headway, weekend service to Bourne terminating either at Buzzards Bay or at Sagamore would require two train sets.

Compared to service terminating at Middleborough/Lakeville, Saturday service with nine round trips would generate 343.8 additional revenue train miles with a Buzzards Bay terminal and 441.0 with a Sagamore terminal. With the two train sets each making one non-revenue round trip from the Middleborough layover facility to the outer terminal, total incremental train miles would be 420.2 with a Buzzards Bay terminal and 539 with a Sagamore terminal.

A Buzzards Bay terminal with no non-revenue trips would add \$13,580 per Saturday in operating costs. With a Buzzards Bay terminal and equipment based at Middleborough, the cost would be \$16,600 per Saturday. The cost with a Sagamore terminal and no non-revenue miles would be \$17,420 per Saturday. The cost with a Sagamore terminal and equipment based at Middleborough would be \$21,290.

Compared to service terminating at Middleborough/Lakeville, Sunday service with seven round trips would generate 267.4 additional revenue train-miles with a Buzzards Bay terminal and 343.0 with a Sagamore terminal. With the two train sets each making one non-revenue round trip from the Middleborough layover facility to the outer terminal, total incremental train miles would be 343.8 with a Buzzards Bay terminal and 441.0 with a Sagamore terminal.

A Buzzards Bay terminal with no non-revenue trips would add \$10,562 per Sunday in operating costs. With a Buzzards Bay terminal and equipment based at Middleborough, the cost would be \$13,580 per Sunday. The cost with a Sagamore terminal and no non-revenue miles would be \$13,550 per Sunday. The

cost with a Sagamore terminal and equipment based at Middleborough would be \$17,420.

Based on present scheduling practice, in a typical year the weekday schedule would be operated on 251 days. The Saturday schedule would be operated on 52 Saturdays and two holidays. The Sunday schedule would be operated on 52 Sundays and five holidays. On three other holidays, a modified weekday schedule with service levels between those of the weekday and holiday schedules would be run. Applying these factors to the operating costs calculated above, the annual operating cost increase for Bourne extensions to Buzzards Bay and to Sagamore with and without layover facilities near the terminal would be as follows:

Buzzards Bay terminal with layover facility	\$6.69 million
Buzzards Bay terminal with trains based at Middleborough	\$8.93 million
Sagamore terminal with layover facility	\$8.58 million
Sagamore terminal with trains based at Middleborough	\$11.46 million

### Operating Revenue

For purposes of revenue calculation, ridership estimates were subdivided into through and interzone trips from each boarding zone, with Wareham in Zone 9 and all stops in Bourne in Zone 10. Interzone trips were further subdivided by alighting zone. Passengers have a choice of a several fare payment options which generate different amounts of revenue for the same trip. The most recent analysis of commuter rail fare mix, based on ticket and pass sales for April 1994, shows that the average revenue for a weekday passenger from Zone 9 to Boston is about \$3.65, equivalent to 77% of the full cash fare of \$4.75. This is used below as the average weekday fare revenue for a passenger from Wareham to Boston. The full from a Zone 10 station would be \$5.50. At 77% of this, the average revenue for a weekday passenger to Boston would be \$4.24<sup>8</sup>.

Interzone passengers have fewer fare payment options than through passengers, as there are no multiple-ride interzone tickets. Interzone passengers typically use commuter rail less frequently than through passengers, and therefore have less incentive to purchase passes. The 1994 fare-mix results show that only 14% of weekday interzone trips were made using passes, compared with 65% of through trips. With a typical interzone fare mix and the origin-destination distribution calculated in the ridership estimates, the average weekday revenue per interzone trip originating on a Bourne extension would be about \$2.47. (When plausible alternate assumptions on interzone fare mix are used, the difference in total estimated revenue is less than 1%.)

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<sup>8</sup>It was necessary to base the zone 10 fare mix on zone 9 data because there were no zone 10 stations when the underlying data were collected.

Applying the average fares above to the estimated demand, using the 1996 ridership estimate, revenue would be \$9,370 per weekday. Weekday peak ridership counts for existing bus service from the extension corridor to Boston show an overall increase of about 8% in June through September compared to other months. Applying this to the totals above would add about \$750 per weekday in the summer.

As discussed in chapter 4, the 1996 ridership totals would include 195 inbound diversions from Middleborough/Lakeville or Kingston. Both of these stations will be in Zone 7. The 1994 fare-mix results show that the average weekday revenue for through passengers to Boston from Zone 7 is \$3.01. This is equivalent to 80% of the one-way cash fare of \$3.75. At this rate, the round-trip revenue generated by the 195 boardings without the extension would be \$1,174. Therefore, the incremental revenue from the extension on non-summer weekdays would be \$8,176.

Saturday and Sunday ridership forecasts have not been made for the Bourne extension. For the commuter rail system as a whole, ridership averaged 29.2% as high on Saturdays as on weekdays and 17% as high on Sundays as on weekdays in April 1994. For purposes of analysis, it is assumed that during non-summer months, a Bourne extension would have ratios of weekend to weekday ridership similar to these. During summer months, recreational travel to Cape Cod would be likely to produce higher ratios of weekend to weekday ridership than these, but how much higher is unclear. For revenue estimation, it has been assumed that Saturday and Sunday ridership would be 50% higher in summer months than in non-summer months. Average fares are higher on weekends than on weekdays because of lower use of passes and multiple-ride tickets. Overall, the April 1994 results showed average Saturday revenue per passenger to be 1.28 times as high as average weekday revenue and average Sunday revenue to be 1.24 times as high.

Applying the combination of factors discussed above to the weekday incremental revenue estimates for the mid-range demand produces estimated incremental revenue of \$3,060 per Saturday and \$1,720 per Sunday in non-summer months.

Weighting revenue for summer and non-summer weekdays, weekend days, and holidays by the number of times that each would occur in a year, incremental annual revenue for the 1996 demand level would be \$2.43 million.

At the 1996 fare levels, the projected ridership in 2010 would result in incremental revenue of \$2.57 million. This would rise to \$2.64 million in 2020. It should be noted that these figures include only incremental revenue for the MBTA. Some of this would represent diversion of revenue from private-carrier express buses. These estimates are relatively insensitive to changes in assumptions about weekend ridership. For example, doubling all of the

Saturday and Sunday estimates would increase the annual revenue total by only 13%.

### **Comparisons of Revenues and Costs**

Although the demand estimates for a Bourne extension were not tied to the individual operating strategies used in the cost estimates, the predicted ridership would be more likely to be attained with a Sagamore terminal than with a Buzzards Bay terminal. (The reason for this is the greater ease of access to Sagamore and Bourne Bridge stations compared with Buzzards Bay.) With the projected annual fare revenue of \$2.43 million and an operating cost of \$8.58 million, service to a Sagamore terminal with a layover facility would have an annual deficit of \$6.15 million. The revenue-to-cost ratio would be 0.28. (Including incremental parking revenue, at \$1.00 per car per day, would add about \$200,000 per year, raising the revenue-to-cost ratio to 0.31.)

With a Buzzards Bay terminal including a layover facility, the annual deficit would be \$4.26 million and the revenue-to-cost ratio would be 0.36. The difficulty in siting parking and layover facilities at Buzzards Bay would make this a less achievable scenario than a Sagamore terminal, however.

Using constant costs and fare structure, increases in ridership between the years 1996, 2010, and 2020 would not improve the revenue-to-cost ratios significantly. A revenue-to-cost ratio of 0.28 would be slightly below average when compared with existing MBTA commuter rail lines. The capital investment of \$34 million would represent a cost of about \$50,700 per new transit user. (This cost would be higher if some parking structures were required.)





## **7. OPERATIONAL ISSUES**

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### **Impacts of Bourne Extension on Other Commuter Rail Services**

Current plans for the Old Colony restoration project call for three branches. The Middleborough/Lakeville line will use the same tracks as the Plymouth line from near the Braintree Red Line station to South Station. The Greenbush line will join the other two at the old Braintree railroad station site between the Braintree and Quincy Adams Red Line stations, and will share the same tracks from there to South Station. The final mile into South Station will use the same right-of-way as the Fairmount line.

When Old Colony passenger service was last operated in 1959, the segment shared by all three routes was entirely double tracked. In earlier years, when there was more frequent service, there were four tracks between North Quincy and South Station. Because of the use of portions of the right-of-way for the South Shore Branch of the Red Line and the Southeast Expressway, the line north of Braintree will now be mostly single track. There will be a double-track section of about three miles near the mid point, and another of about 1.5 miles approaching South Station. At South Station, only two tracks will be available primarily for use of Old Colony trains.

The track constraints and platform capacity constraints will limit the number of time slots available for operation of trains between Braintree and South Station. Analysis for the Old Colony project has determined that provision of levels of service on all three branches comparable to that on other lines in the commuter rail system will require use of all of the available time slots from the outset. The proposed Old Colony schedule has five inbound A.M. peak arrivals from the Middleborough/Lakeville line and four each from the Greenbush and Plymouth lines. Each line would have four outbound departures in the P.M. peak (between 4:00 and 6:30).

Of the 13 trains arriving between 6:30 and 9:30 A.M., six would turn for outbound service in the same time span, one would make another outbound trip after the A.M. peak, and six would go to unspecified layover facilities. With the planned running times, only one train set would be able to complete two inbound trips during the A.M. peak, so the 13 trips would require 12 sets. The other five sets running outbound in the A.M. peak would run inbound next as midday trains.

Of the 12 outbound trains between 4:00 and 6:30 P.M., six would proceed to layover facilities near the outer ends of their routes, and six would turn for inbound service. None of these six would arrive back at South Station before the end of the P.M. peak. Only two inbound trains would be scheduled to arrive at South Station at any time during the P.M. peak, and only the earlier of these would make an outbound peak trip.

In order to increase the number of inbound A.M. peak or outbound P.M. peak trains, it would be necessary to reduce or eliminate reverse-peak direction service during these times. Some earlier and later trips would also be affected. This would result in less efficient service, as train sets and crews would be able to make fewer trips. It would also require more storage capacity for trains at the Boston end, where layover space will already be limited. For these reasons, it is assumed in this study that Bourne service would be operated only if it could be done without increasing the number of peak-direction peak-period Old Colony trips above the number shown in the schedules in the EIR.

A reduction of frequency on any of the Old Colony branches to accommodate Bourne trains would result in inadequate service on those lines. Therefore, Bourne service would have to be operated by extending trains that would otherwise terminate at Middleborough/Lakeville. For the same reasons, if the planned New Bedford/Fall River service were routed via Middleborough rather than via Attleboro, it would also have to be run by extending Middleborough/Lakeville trains. Combining trains from different lines at Middleborough would cause undesirable delays, and could also result in trains too long for the platforms at South Station. Alternating the outer destinations of Middleborough trains among routes would provide insufficient service on any of the extensions. Therefore, Bourne service and New Bedford/Fall River service via Middleborough must be considered to be mutually exclusive.

Assuming that Bourne trains were run beyond Middleborough, using time slots north of Braintree already planned for trains terminating at Middleborough/Lakeville, one impact on operations would be a reduction in schedule reliability. Under the tentative schedule in the EIR, four of the five inbound A.M. peak trains from Middleborough/Lakeville would be run with train sets kept there overnight. Barring mechanical problems, all of these trips should be able to depart from the outer terminal on time. The fifth trip would turn from an outbound train scheduled to arrive ten minutes before departure, but subject to delays from passing inbound trains.

With the extension of service to Bourne, even if trains were dispatched from there on time, there would be a greater chance of late departures from Middleborough because of possible delays during the Bourne to Middleborough run. The impact of such delays would be magnified north of Middleborough because of the need to merge with the other two branches and to pass outbound trains at specific passing sidings or on double-track sections of limited length. Longer trains required by additional ridership from Wareham and Bourne could also have some impact on train acceleration, affecting overall running times.

#### Impacts on Amtrak and Excursion Train Service

At present, the only passenger train service on the line between Middleborough/Lakeville and Bourne consists of summer weekend trains to and from Hyannis

operated by Amtrak. Each year since this service began in 1986, there has been one train to Cape Cod on Friday evenings and one train from the Cape on Sunday afternoons. In some years there has also been a trip from the Cape on Saturday mornings and a trip to the Cape on Saturday afternoons. The Friday train has always entered the segment between Middleborough and Buzzards Bay long after the time that P.M. peak commuter trains from Boston would need to use it. The ridership levels on the Amtrak trains have not been sufficient to justify implementation of more service at any time in the foreseeable future. Therefore, little or no scheduling conflict between future commuter service and intercity service is likely.

The Cape Cod Scenic Railroad operates excursion and dinner trains between Hyannis and a passing track east of the Sagamore Bridge on most summer days and on selected weekends in non-summer months. Commuter service to a Sagamore terminal at the Canal Electric site would share the same route for about one mile. Most of the excursion trains use historical rolling stock and must operate to locations where engines can be run around the cars. The 1996 summer schedule has four round trips daily except Mondays, but none of these trains are scheduled to be in the Sagamore area during times when peak-period commuter trains would be arriving or departing. Some adjustments in the excursion train operation to avoid conflicts with midday and early evening commuter trains would be needed. Separate run-around tracks for the excursion trains might be included in the design of the Sagamore commuter rail terminal. Facilities for convenient transfers between the commuter trains and the excursion trains at Sagamore could enhance ridership levels on both.

### **Impacts on Freight Service**

Freight service on the Buzzards Bay and Hyannis Secondary tracks on a typical day consists of one round trip to Middleborough for general freight and one or two round trip to the SEMASS incinerator in Rochester, carrying trash from transfer stations at Otis Air Force Base and at Sagamore. Operation of commuter service would reduce flexibility in the times at which these trains could be operated, but conflicts would be no more serious than those on most other lines in the commuter rail system.

North of Middleborough, freight service is operated as far as Braintree. Bourne service would not change the number of passenger trains operating on this line, so the impact on freight service would be no different from that of Old Colony service terminating at Middleborough/Lakeville.

### **Impacts on Train Lengths**

The Old Colony Rehabilitation Project EIR includes ridership projections only for the year 2000, and only for weekday A.M. peak inbound service. For the alternative closest to that which is now planned, the forecast for the

Middleborough/Lakeville line for this time span is 4,696 riders. If divided uniformly among the five A.M. peak trains, this would be 939 riders each. Demand for commuter rail (as for other transit services) is not uniform throughout peak periods, however. Alighting counts on the South Side commuter rail lines conducted by CTPS in 1993 found that on lines with five inbound A.M. peak arrivals, the most heavily patronized trip carried 28% to 33% of the five-train total. The most popular Boston arrival time was usually between 8:00 and 8:30. With similar distribution of riders, the most heavily patronized Middleborough train would have between 1,315 and 1,550 riders. (The EIR estimates do not specify if they include interzone riders, but the number of these on an individual train would be small in any case.)

The highest-capacity commuter rail cars now operated by the MBTA are the Kawasaki double-deckers. These have 185 seats per car in the non-cab cars and 175 in the cab cars. Each train must include at least one cab car. The shortest train that could provide seats for all riders on the heaviest Middleborough trip would consist of eight cars with 1,470 seats for the 1,315 rider estimate, and nine cars with 1,645 seats for the 1,550-rider estimate.

Demand estimates for a Bourne extension are contained in chapter 4 of this report. Estimates are included for the years 1996, 2010, and 2020. The estimates for 1996 indicate that with all Middleborough trains extended to Bourne, 1,135 riders per day would board at stations in Bourne or Wareham and ride through to Boston. Of these, about 965 would ride in the A.M. peak. Based on the forecasts in the Old Colony EIR, most of the diversions to a Bourne extension from other commuter rail service would come from the Plymouth line. Therefore, the net increase in ridership on the Middleborough/Lakeville line would be only slightly less than the total number of riders on the extension.

Assuming the same concentration found on existing South Side trains, the most heavily used trip would carry between 320 and 375 passengers from stations on the extension to Boston. This would require the equivalent of the seating capacity of one entire double-deck car plus 75 to 100% of the capacity of a second car.

Combining the ridership from north and south of Middleborough, the most heavily loaded train would carry between 1,635 and 1,925 riders. These estimates would require minimum train lengths of 9 and 11 cars, respectively. The planned platform length at Old Colony stations is only eight cars, so trains of either 9 or 11 cars could not stop with all doors on the platforms<sup>9</sup>.

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<sup>9</sup>To maintain adequate acceleration, current MBTA locomotives are limited to train lengths of nine cars. An eleven-car train would require either two locomotives or use of higher-horsepower units.

Only one of the five A.M. peak trains would have potential ridership as high as that estimated above. To some extent, a problem of demand in excess of seating capacity would be self-correcting. If the train at the most popular Boston arrival time proved to be routinely overcrowded, some passengers would either shift to different trains or use other means of transportation.

### **Impacts at South Station**

In conjunction with the Old Colony project, two tracks have been added at South Station. These tracks, designated Track 12 and Track 13, are on the east side of the station. Track 13 can hold a maximum of six cars and one locomotive without blocking the approach to Track 12. Track 12 can hold a maximum of seven cars and one locomotive without blocking the approach to Track 13.

In the past, Track 11 has been used mostly by Fairmount Line trains, but as these have relatively low average ridership they will be shifted to Track 13, making Track 11 available for Old Colony service. The Track 11 platform is between 10 and 11 car-lengths long. With the existing switch arrangement, a train of more than seven cars on Track 11 would block access to Track 12, but this situation is to be corrected. Using Track 11, the longest predicted Bourne train, 11 cars, would be able to have all doors except the furthest one out on the platform open.

An alighting volume of 1,635 or more riders at South Station from a single train would be much heavier than the maximum alightings there from any existing train there. Boston alightings from the most heavily patronized trains are now divided between Back Bay and South Station, but Bourne trains will be able to serve only South Station. Control counts taken for the 1993 commuter rail survey found a maximum of about 800 South Station alightings from any individual train, with most volumes being much lower than this. Unusually long unloading times likely for the peak Bourne trains would affect the ability to remove these trains quickly from the platforms to clear the way for the next arrivals. It could also prove difficult to load the most heavily patronized outbound P.M. peak trains during their scheduled dwell times in the station.

### **Impacts on Marine Traffic of Cape Cod Canal Crossing**

A rail extension beyond Buzzards Bay would have to cross the vertical-lift bridge over the Cape Cod Canal. This bridge is owned, operated, and maintained by the U.S. Army Corps of Engineers. Except when trains are crossing, the bridge is normally kept in the open position, as it has insufficient clearance below for most marine craft when closed. At the bridge, marine traffic is given precedence over unscheduled rail traffic such as freight trains or special excursions. For Amtrak seasonal trains, which run on a schedule, the bridge is lowered at pre-arranged times, provided that trains are no more than 15 minutes late. Trains arriving more than 15 minutes behind schedule must wait for marine traffic to

clear the bridge before it is closed. (Delays of about five minutes have been noted in random observations.)

A commuter rail extension would involve a much larger number of train crossings of the canal than are currently scheduled or have been scheduled at any time in the past. With all Middleborough/Lakeville trains extended to a terminal south of the canal, there would be 14 round trips on weekdays, nine on Saturdays, and seven on Sundays. Present Amtrak service, which runs from late June to late September, consists of one southbound train on Friday evenings and one northbound on Sunday afternoons. There are no regular excursion trains crossing the canal at present. Excursion trains that operated in the 1980s reached a maximum frequency of eight round trips per day, with four each to Hyannis and Falmouth. These were scheduled so that Hyannis and Falmouth trains always crossed the bridge in close succession, requiring a single bridge lowering for every two trains.

Prior to the discontinuance of year-round passenger train service to Cape Cod in 1959, seven round trips were scheduled to cross the canal on weekdays in non-summer months. There were four round trips to Hyannis and three to Woods Hole. In summer months, this increased to six round trips to Hyannis and five to Woods Hole on Monday through Thursday, making a total of 11 round trips. On Friday nights there were an additional two trains to Hyannis and three to Woods Hole and one additional train from Hyannis, making a total of 16 trains crossing the canal southbound and 12 northbound. Like the later excursion trains, these Hyannis and Woods Hole trains usually crossed the bridge in close succession, requiring a single bridge lowering for two trains. This schedule is representative of the maximum level of train service crossing the canal at any time after the construction of the present bridge in 1935.

Further analysis would be needed to determine the number of commuter trains that could be operated across the canal without unacceptable delays to either marine traffic or the trains themselves. Some negotiation with the Corps of Engineers on the number of pre-determined bridge closing times would also be needed.

Because of the track capacity constraints between Braintree and Boston, it will be essential that inbound trains from all Old Colony branches enter this segment at or very close to their scheduled times. If the canal crossing is likely to cause significant delays to trains on a regular basis, an extension south of Buzzards Bay may not be feasible. A Sagamore terminal would be only five to six miles from the bridge, on a grade-separated alignment, so trains leaving Sagamore on schedule should usually be able to reach the bridge on time. Strategies for further ensuring against late arrival at Braintree could include providing allowances for delays of Sagamore trains in the schedule, or originating selected trips at Buzzards Bay rather than Sagamore.

## 8. ENVIRONMENTAL AND COMMUNITY IMPACTS

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### Air Quality Impacts

Air quality impacts of transit projects are typically calculated on the basis of expected changes in vehicle miles of travel (VMT) resulting from the project. Measurement of such changes for a Bourne extension requires calculations of the total VMT that would be generated by the riders of the extension in using it and the total VMT that would be generated in completing the same trips in the absence of the extension. Details of these calculations appear in Appendix E.

The midpoint demand estimate for 1996 would result in a net reduction of 53,350 VMT per weekday for an extension terminating at Buzzards Bay. A further extension with stations at the south ends of the Bourne and Sagamore bridges would shorten access trips for passengers diverted from the Buzzards Bay Station. This would increase the VMT reductions and consequent air quality improvements by about 11% compared with a Buzzards Bay terminal. Using current emission factors for vehicles moving at the average speeds observed from Wareham and points in Barnstable County to Boston, this would produce reductions in carbon monoxide (CO), nitrous oxides (NO<sub>x</sub>), and volatile organic compounds (VOC) as shown in Table 8-1.

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Table 8-1  
Average Weekday Traffic and Air Quality Impacts of Bourne Commuter Rail  
Extension at 1996 Travel Levels

	Buzzards Bay Terminal	Sagamore Terminal
VMT Reduction	53,350	59,220
CO Reduction	535.4 kg	594.3 kg
NO <sub>x</sub> Reduction	90.5 kg	100.5 kg
VOC Reduction	49.9 kg	55.4 kg

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At the same time, however, the diesel locomotives used on trains would add emissions to the air. In addition to CO, NO<sub>x</sub> and VOC, particulate matter (PM) is of concern for diesel vehicles. For extensions to Buzzards Bay or Sagamore with 14 round trips per day, and no non-revenue miles, locomotive emission increases would be as shown in Table 8-2.

The net impact of the reduction in auto emissions and increase in locomotive emissions would be as shown in Table 8-3. As can be seen from the tables, an extension to either Buzzards Bay or Sagamore would result in overall reduction in CO and VOC levels, but increases in NO<sub>x</sub> and PM levels.

Table 8-2  
Bourne Extension  
Increase in Average Weekday Train Emissions

	Buzzards Bay Terminal	Sagamore Terminal
CO Increase	22.9 kg	30.2 kg
NOx Increase	257.1 kg	335.0 kg
VOC Increase	8.0 kg	10.6 kg
PM Increase	3.5 kg	4.5 kg

Table 8-3  
Bourne Extension  
Net Changes in Average Weekday Emissions

	Buzzards Bay Terminal	Sagamore Terminal
CO change	-512.5 kg	-564.1 kg
NOx change	+166.6 kg	+234.5 kg
VOC change	-41.9 kg	-44.8 kg
PM change	+3.5 kg	+4.5 kg

### **Impacts on Water Resources**

The rail lines that would be used for a Bourne extension are currently all single tracked. The entire line between Middleborough/Lakeville and Buzzards Bay was formerly double tracked and could accommodate passing sidings wherever needed with no additional grading or land-taking. Therefore, the only expected land-form changes possibly affecting water flow would occur at station areas.

The Final Environmental Impact Report for the Old Colony Rehabilitation project concluded that pollutants such as oil and brake dust dropped on railbeds by trains would be in low concentrations and would be unlikely to migrate to wetlands, waterways, or groundwater in significant volumes. Runoff of pollutants from parking lots was considered to be a more likely problem, which would need to be dealt with by use of appropriate drainage systems and lot maintenance strategies.

All of the station locations on a Bourne extension that have been assumed for purposes of analysis would be close to waterways. The present Amtrak Wareham Station site is at the junction of the Agawam and Wareham rivers, but the track is located between the parking lot and the water. The Buzzards Bay, Bourne Bridge, and Sagamore stations would all be near the edges of the Cape



Cod Canal. The most likely sites for a Bourne Bridge station include vacant wooded tracts that may qualify as wetlands. A Sagamore station at the Canal Electric site would provide an opportunity for cleaning up a long-established industrial area.

### **Impacts on Cultural Resources**

Impacts on cultural resources cover changes that would occur to historic buildings, sites, and districts, to archeological sites, to parks and open spaces, and to buildings and resources that are important to the expression of cultural values, such as schools, churches, and monuments.

Since a Bourne extension would use an active rail right-of-way which would not need to be widened, the only necessary taking of land would occur at stations. Land uses at other points could, however be impacted by their proximity to the rail line. There are no public parks in the vicinity of the rail line between Middleborough/Lakeville and Buzzards Bay. Between the Bourne Bridge and Sagamore, the rail line runs along the south bank of the Cape Cod Canal, with a paved bicycle path between the track and the water. Operation of commuter trains in this section and safety fencing along the right-of-way would negatively impact the aesthetic quality of the bicycle path. A picnic area overlooking the canal is located about halfway between the highway bridges but is separated from the rail line by Route 6.

One church abuts the right-of-way, at Rock Village in Middleborough. The Decas School and its playground adjoin the rail line at Station Street in Wareham. The historic Tremont Nail Company factory is located near the Elm Street crossing in Wareham. This is a popular tourist attraction, and Elm Street is one of the approach routes to it. The existence of archeological sites along the rail line has not been determined.

### **Traffic Impacts on Major Arterial Routes**

Data on auto trips from the Bourne extension corridor to Boston and Cambridge are not broken down by individual route, but reasonable assumptions can be made on the basis of route locations and travel times. Traffic from Wareham, Marion, most of Bourne, and Falmouth would be most likely to use Routes I-495, 24, and I-93. Traffic from Rochester and Mattapoisett either would use this same combination from Wareham or would join it in Raynham via Routes 140 and 24. Traffic from all other origins south of the Cape Cod Canal would be most likely to use Routes 3 and I-93, joining traffic from the other towns on the Southeast Expressway north of Braintree. Interzone trips other than those to Braintree or Quincy would mostly use Routes 25 and I-495 as far north as Middleborough. Braintree and Quincy trips would split in the same fashion as Boston and Cambridge trips. Table 8-2 summarizes traffic impacts on selected roads.

Table 8-2  
Change in Inbound Daily and Peak 30-Minute Auto Traffic on Selected Roads  
Resulting from Bourne Extension with 1996 Mid-Range Demand Estimate

<u>Road</u>	<u>Inbound Daily Change</u>	<u>Inbound Peak 30-Min. Change</u>
Southeast Expressway	-490	-135
Route 3	-390	-110
Route 24	-245	-70
Bourne Bridge with Buzzards Bay Terminal	+40	+10
Sagamore Bridge with Buzzards Bay Terminal	+105	+30
Bourne Bridge with Sagamore Terminal	-100	-28
Sagamore Bridge with Sagamore Terminal	-355	-100

The greatest reduction in traffic as a result of the Bourne extension would occur on the Southeast Expressway just north of Route 3. At 1996 traffic levels, the reduction there would be 490 inbound auto trips per day. The maximum reduction in any 30-minute interval would occur between about 8:00 and 8:30 A.M., when 135 autos would be removed. This would represent a decrease of about 3% in the peak traffic level on the Expressway.

On Route 3 between the Sagamore Bridge and Kingston, the Bourne extension would remove 390 inbound autos per day. The peak 30-minute reduction would be 110.

The largest reduction in traffic on Route 24 would occur just north of the interchange with I-495 in Raynham. There, the extension would remove 245 inbound autos per day at 1996 traffic levels. The peak 30-minute reduction would be 70 autos. Traffic reductions on I-495 just south of the exit to the Middleborough/Lakeville station would be slightly higher than these, but overall traffic volumes on that segment are lower.

With the outer terminal of the extension located at Buzzards Bay, there would be no reduction in traffic crossing the Bourne and Sagamore Bridges. To the contrary, traffic would increase slightly as a result of diversions to Buzzards Bay from express bus stops south of the canal. On the Bourne Bridge, the increase would be about 40 cars each way per day, or 10 cars in the peak half hour in the peak direction. On the Sagamore Bridge, the increase would be about 105 cars per day, or 30 cars in the peak half hour in the peak direction.

A further extension beyond Buzzards Bay with stations near the southern ends of the Bourne and Sagamore bridges would reduce the traffic levels on both of them. On the Bourne Bridge, the reduction would be 100 inbound autos per day at 1996 traffic levels. The peak 30-minute reduction would be 28. On the Sagamore Bridge, there would be a reduction of 355 inbound autos per day and 100 in the peak hour at 1996 traffic levels.

### **Traffic Impacts of Station Access**

To the extent that the impacts of stations on surrounding areas would be site-specific, they are beyond the scope of this study. Certain impacts could be expected regardless of station location, however. As discussed in Chapter 3, every station site would require some use of undivided highways or local streets for final access. Most of this would consist of traffic that now bypasses these areas on limited-access highways, so there would be some localized increases in traffic congestion at all sites.

The demand forecasts in Chapter 4 indicate that if service were in operation today with unconstrained parking capacity at stations in Wareham and at Buzzards Bay but with some express bus service also provided, ridership would be about 1,200 per day. The Wareham station would be used mostly by passengers with trips originating in Wareham, Rochester, Marion, or Mattapoisett. The Buzzards Bay station would serve passengers from Bourne and all other towns on Cape Cod if it were the outermost station on the line. With this allocation, ridership at Wareham would be about 385 per day, and that at Buzzards Bay about 825.

With 85% of daily ridership during the A.M. peak and 33% of peak ridership on the most heavily patronized train (as is typical on current MBTA commuter rail lines), the heaviest ridership on an individual train would be about 110 at Wareham and 230 at Buzzards Bay. Because of the relatively low population densities of Wareham and Bourne, only about 5% of the passengers using the station in Wareham and about 4% of those using a Buzzards Bay station would have trip origins within walking distance of their stations. The low population density would likewise prevent design of feeder bus routes that could stop within convenient distance of large numbers of trip origins and also be sufficiently direct to be time-competitive with auto access. Bicycle access accounts for much smaller percentages of access trips than walk-ins at all MBTA commuter rail stations. Therefore, for planning purposes it must be assumed that passengers who did not walk to either the Wareham or Buzzards Bay station would arrive by auto as park-and-ride drivers or passengers or by being dropped off.

The 1993 commuter rail survey did not provide information on average occupancy of vehicles parked at stations. In conjunction with the survey, however, direct observations were made of auto occupancy at the Dedham

Corporate Center Station on the Franklin line, which shares many of the expected characteristics of stations on a Bourne extension. It is a regional facility drawing patronage from a large number of towns, and over 98% of its riders use some form of auto access. The observations there showed only 1.03 riders per parked car, with no more than one passenger being dropped off from any vehicle that did not park.

Applying a composite of the factors above, the most heavily patronized train on a Bourne extension would attract about 100 auto-access trips to Wareham Station and 220 at Buzzards Bay. The 1993 commuter rail survey found that at stations with high auto-access rates, one half to two thirds of passengers typically arrive at their boarding stations six minutes or less prior to scheduled train departure. With similar arrival patterns, traffic in the six minutes before the departure of the most heavily patronized train would average up to 11 cars per minute at Wareham and 24 at Buzzards Bay. At Wareham, this traffic would approach the station from both east and west. All traffic at Buzzards Bay would arrive from the east.

P.M. peak ridership typically shows lower maximum train loadings than A.M. peak ridership on a given route. Most alighting passengers leaving a station by auto attempt to do so immediately after train arrival rather than over the course of five to ten minutes, however, so congestion following evening train arrivals would likely be more severe than that prior to morning departures.

The ability of the roads at Wareham and Buzzards Bay to accommodate vehicles going to and from the stations in addition to existing traffic would require more detailed analysis than is covered by the scope of this study. For comparison, the most heavily patronized stations in the MBTA commuter rail system serve a maximum of about 325 auto-access passengers per train. At these stations, congestion is mitigated by multiple approach routes, multiple parking sites, and arrival of only 46% to 56% of vehicles in the final six minutes before train departure.

To accommodate the maximum projected ridership for a Bourne extension with less traffic congestion, boardings and alightings could be dispersed among more than two stations. Historically, Wareham was always served by at least two stations during the years when passenger service to Boston was operated. Dividing Buzzards Bay traffic would require further extension to some point on the south side of the canal. As discussed elsewhere in this report, such an extension should, if possible, include stations designed to intercept traffic bound for both of the highway bridges over the canal. A station near the Bourne Bridge would serve traffic from most sections of Bourne south of the canal except for Sagamore and would also serve traffic from Falmouth. A station near the Sagamore Bridge would serve the remainder of the Cape. If both stations were provided, they would divert nearly all of the riders from the Buzzards Bay station. (This is consistent with the present boardings on express bus routes, on

which stops near the bridges serve far more riders than the downtown Buzzards Bay stop.) Therefore, a major investment in permanent parking facilities at Buzzards Bay should not be made if a further extension is anticipated.

At 1996 non-summer travel levels, a Bourne Bridge station would serve about 205 riders per day, of which all but about 10 would rely on auto access. The most heavily patronized train would attract about 60 auto access trips, with a maximum arrival rate of seven per minute.

A Sagamore station, which would serve a much larger portion of the Cape, would be used by about 590 riders per non-summer day, of which all but about 15 would use auto access. The most heavily patronized train would attract up to 155 auto-access trips, with a maximum arrival rate of 18 per minute. Most of the auto trips to this station would otherwise cross the Sagamore Bridge, but would not be concentrated in as short a time span. Fewer than 50 riders per day would continue to use a Buzzards Bay station if both of the other stations were also provided and had unconstrained parking. Ridership at a Bourne Bridge station would not be affected by a further extension of rail service beyond Sagamore. A Sagamore station would lose up to 75% of its ridership to an extension to or toward Hyannis.

### **Impacts of Grade Crossings**

At present, there are 11 grade crossings of public roads between Middleborough/Lakeville and Buzzards Bay, with an overall average spacing of 1.9 miles. The greatest concentration of these crossings is in the town of Wareham, where there are seven crossings in one segment of 5.5 miles. The minimum separation there is 0.4 mile. The only grade crossing of a numbered highway is that of U.S. Route 6 in the center of Wareham, near the traditional Wareham Station location. Train operation there could result in some backup of traffic at peak times, particularly in summer months. More detailed traffic studies of this crossing would be needed prior to implementation of service. Most of the other crossings are on streets that appear to be used mainly by local traffic at low volumes.

The Depot Street and Main Avenue crossings in Wareham are both on access routes to the summer resort area of Onset, and may be heavily traveled at times. The Academy Drive crossing in Buzzards Bay, at the present station, is the main access route to the Massachusetts Maritime Academy. It also serves a large private boat marina, which is active mostly during summer months. A grade-separated connection from Academy Drive to Main Street was formerly provided by the Taylor Avenue bridge over the tracks, just to the west. This bridge and the fill for the south approach were removed several years ago. The marina parking lot is partly on the site of the removed fill.

All of the public crossings are protected by flashing lights. All except the Academy Drive crossing are also protected by automatic gates. All of the crossing protection devices were functioning properly as of June 1996. There is also at least one active farm crossing on private property, protected only by stop signs. Between Buzzards Bay and Sagamore there are no grade crossings of public roads, but the Corps of Engineers has several private crossings for access to the canal.

### **Impacts on Abutters**

South of Middleborough/Lakeville the entire Bourne extension would use an active rail line which has been in continuous operation since 1848. Commuter service would involve a much greater number of trains than have been run in recent years, however. Passenger service on this line is currently operated only on summer weekends and does not exceed one train per day. The number of freight trains usually does not exceed one or two a day in each direction. Negative impacts of the increased service would include vibration and noise, and increased blocking of road crossings while trains are passing. The sounds that would carry furthest would be those of train horns at the crossings.

A field inspection by CTPS in April 1996 found that much of the land along the rail line either is undeveloped or is non-residential in character. In many places, development along the right-of-way could occur only if new access roads were first built. New housing is under construction or has recently been completed on streets within half a mile of the line in several places, however.

As of April 1996, there were approximately 75 houses located within 200 feet of the rail line between the Middleborough/Lakeville and Buzzards Bay station sites, or an overall average of four per mile. About 60 of these houses, or 80%, were in the six miles between the Main Street bridge at Parker Mills and the Onset Avenue bridge, both in Wareham.

At each of the eleven grade crossings of a road with the railroad in this segment, land uses were noted separately in four directions or quadrants (on each side of the road and on each side of the railroad.) Within each quadrant the impact of train operation would be greatest for the parcels immediately bordering on the railroad track. Of the four parcels bordering on both the road and the railroad at each crossing, an average of 1.3 were occupied by houses, 1.2 by commercial or industrial buildings, and 0.5 by other structures, and 1.1 were vacant. The other structures included one elementary school, at the Station Street crossing in Wareham.

About two thirds of the houses within 200 feet of the railroad are provided with some sound buffering by the earth cuts for the tracks and by embankments for road approaches to bridges. In addition, much of the land along the railroad, including that around houses, is heavily wooded.

Between the south end of the lift bridge over the canal and the end of the Bourne Bridge, there are several recent housing developments. An inventory of the number of houses in these developments was not taken, but the majority are more than 200 feet from the railroad track and are also at a higher elevation. From the Bourne Bridge to about one half mile west of the Sagamore Bridge, most of the land in the vicinity of the railroad is undeveloped. There are some houses of various ages in the vicinity of the Sagamore Bridge, but most of these are over 200 feet from the track and at a higher elevation.





## **9. SUMMARY AND CONCLUSIONS**

An extension of commuter rail service on the Old Colony Middleborough/Lakeville route to Bourne would be feasible from an operations standpoint, but would produce relatively limited benefits. At current travel levels, about 1,200 riders in each direction would ride trains on the extension on non-summer weekdays. Of these, about 530 would be diverted from other transit service, and 670 would be former auto drivers or passengers. The maximum highway traffic impact of the extension would be felt on the Southeast Expressway, where there would be a reduction of about 3% in the number of peak-direction vehicles during commuting hours. Future growth in travel would increase ridership on the extension by less than 10% over the 1996 level by the year 2020.

Station locations best suited for serving commuter traffic (near the Bourne and Sagamore Bridges, and in Wareham) would be too far from beaches or ferry terminals to attract significant shares of summer and weekend recreational travel to the Cape. Travel times from all points on the extension would be about the same as those for single-occupant auto trips, but somewhat slower than express bus trips routed through the Southeast Expressway High Occupancy Vehicle lane.

Incremental fare revenue from the extension would cover about 28% of incremental operating cost, which would be below average for MBTA commuter rail service. Capital costs for necessary right-of-way improvements, station platforms and parking, and additional rolling stock would total about \$33 million assuming use only of surface lots for parking. Because of the wide dispersal of trip origins, a total of about 1,000 parking spaces would be needed to attain the projected ridership level.



## **APPENDIX A - FURTHER DETAILS ON EXISTING PUBLIC TRANSPORTATION SERVICE IN STUDY AREA**

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Chapter 2 of this report contains an overview of present public transportation in the expected service area of a Bourne commuter rail extension. This appendix describes the present services in greater detail, first for towns directly along the rail line, then for contiguous towns, and finally for other towns on Cape Cod. Published running times for each route are based on schedules that were in effect in the spring of 1996. Information on the on-time performance of these routes is not readily available. Automobile travel time runs conducted by CTPS in 1994 and 1995 on the most congested portions of the same highways used by the buses suggest that actual bus times of five to ten minutes longer than those shown in the schedules would be typical during peak hours.

### **On-Line Towns**

#### ***Wareham***

Bus service between Wareham and Boston is currently operated by Bonanza Bus Lines. This service is unsubsidized. All trips make a stop at the Mill Pond Diner on state Route 28 at Tihonet Road in Wareham, and run non-stop between there and South Station via Routes 25, I-495, 24, and I-93. The scheduled running time is one hour in each direction.

On weekdays, there are five inbound and four outbound trips on this route. Two of the inbounds and three of the outbounds have schedules suitable for Boston commuting. Two of the inbound trips and one of the outbounds, all in commuting hours, also stop at the old Wareham railroad station site, behind the Main Street business district. The scheduled time between there and South Station is 65 minutes, or 5 minutes longer than from the Mill Pond Diner. These trips run through to Buzzards Bay via Route 28. On Saturdays and Sundays there are three trips inbound and four outbound between Wareham and Boston. The Wareham trips that do not go to Buzzards Bay run through to Woods Hole except in summer months, when some are run as separate sections.

The 1990 Census figures show 30 work trips by Wareham residents via bus to downtown Boston, 12 to other parts of Boston, and 8 to Cambridge, for a total of 50. This represented a share of slightly below 10% of the total 507 work trips from Wareham to Boston and Cambridge. Most of the bus trips were presumably made via the Bonanza route, which provided a peak-period, peak-direction total of about 90 seats per day at the time. The level of A.M. peak inbound service has not changed since 1990, but the number of outbound P.M. peak trips has been increased from two to three.

Passenger counts from 1995 shows that there are 55 to 65 inbound A.M. peak passengers per day on this route, but this includes boardings at both Buzzards

Bay and Wareham, and possibly passengers from other towns boarding at these stops. There are 30 parking spaces for Bonanza Bus passengers in an unpaved lot behind the Mill Pond Diner, and 69 spaces at Wareham Station. A weekday count in April 1996 found all spaces at the Mill Pond Diner occupied after the departure of the two A.M. peak trips and one mid-morning trip. At Wareham Station, 22 commuter parking spaces were occupied, but some of the vehicles may have been left by car-poolers. The ticket agent for the Wareham Station stop indicated that about 30 riders a day board there in non-summer months, and 40 to 45 in summer months. (There is no off-peak service at this stop.)

The Census figures show no other Wareham-Boston trips by public transportation. Likewise, the 1993 commuter rail survey had no responses from Wareham residents.

### ***Bourne***

Bus service between Bourne and Boston is currently provided by two routes operated by Bonanza Bus Lines and one route operated by the Plymouth & Brockton Street Railway Company. Service between Buzzards Bay and Boston is provided by the extension of selected trips on the Bonanza Wareham route. On weekdays there are two inbound trips, both arriving in Boston in the A.M. peak, and one outbound trip, leaving Boston in the P.M. peak. There is no weekend or holiday service. These trips stop on Main Street in Buzzards Bay, near the former railroad station. The scheduled running time between there and South Station is 80 minutes in each direction.

Census figures for travel from Buzzards Bay alone are not available, because it is part of the town of Bourne. The lower level of service provided to Buzzards Bay implies that ridership is lower there than at Wareham, however. (In 1990 there were two outbound P.M. peak trips to Buzzards Bay, but the later of these was discontinued in 1991). Parking lots around the rail station will accommodate about 100 cars, but an April 1996 weekday check found fewer than 25 spaces occupied. None of the parked cars were clearly identifiable as belonging to bus commuters. The 1993 commuter rail survey included one response from a Buzzards Bay resident working in Boston. This respondent drove to Route 128 Station to board.

Most service to Bourne operated by Bonanza Bus Lines is now provided not by the Buzzards Bay route, but by their route from Woods Hole and Falmouth to Boston. This service is also unsubsidized. The main Bourne stop on this route is at the Tedeschi Food Shop on Trowbridge Road, (near the south end of the Bourne Bridge over the Cape Cod Canal) off the rotary where state Route 28 and U.S. Route 6 meet. The Trowbridge Road site has more direct access than Buzzards Bay from most of the town of Bourne, and avoids the need for passengers to cross the canal bridges in their own vehicles. The Tedeschi's parking lot has 42 spaces designated for Bonanza Bus passengers. All were

occupied during an early-afternoon count in April 1996. (Some cars may have belonged to passengers using the Bonanza route to Providence, which also serves this stop.) Commuter parking is not allowed in other sections of this lot.

There is also a flag stop in Bourne at the Route 28 rotary at the entrance road to Otis Air Force Base. This stop serves the Pocasset section of the town in addition to the Air Base. There is no off-street parking in the immediate vicinity. Buses operate between the two Bourne stops via Route 28, which is divided, but does not have controlled access in this section.

Between the Bourne Bridge and South Station, buses run via Routes 25, I-495, 24, and I-93, either non-stop or with one intermediate stop at the Mill Pond Diner in Wareham. South Station is now the only downtown Boston stop on this route, but most trips run through to Logan Airport. The scheduled running time between the Trowbridge Road Bourne stop and South Station varies from 65 to 70 minutes. The time from the Otis AFB stop is ten minutes longer.

During non-summer months, the Trowbridge Road and Otis stops are served by 11 round trips per day, including three inbound arrivals in Boston in the A.M. peak and four outbound departures in the P.M. peak. Eight trips in each direction serve Logan Airport. There are nine round trips on Saturdays and eight on Sundays. Service levels are increased during summer months, but the additional trips typically run in off-peak hours.

The level of A.M. peak service was the same in 1996 as in 1990, but the four outbound P.M. peak trips included one new one. (This was the same new trip added to Wareham service.)

The Plymouth & Brockton Street Railway Company (P&B) provides commuter bus service to Bourne as an intermediate point on a route from Hyannis to Boston. This service is partially subsidized through IDTS and CCRTA funding. The stop on this route is at the state-owned park-and-ride lot at the Sagamore traffic circle, at the north end of the Sagamore Bridge over the canal. This location is five miles east of the Buzzards Bay railroad station. Between there and Boston, buses follow Routes 3 and I-93. Most off-peak trips and some peak trips include an intermediate stop at the P&B terminal at Exit 7 in North Plymouth. Some off-peak trips stop at a park-and-ride lot at Route 228 in Rockland. The Sagamore park-and-ride lot has about 400 spaces, but none are marked specifically for bus passengers. An April 1996 mid-day check found the lot about 90% full.

All trips serve the South Station Transportation Center, and the majority also serve Park Square. Trips arriving in Boston before 10:00 A.M. and serving both stops go to South Station first, then continue to Park Square. Trips arriving in Boston after 10:00 A.M. stop at Park Square on the way to South Station. Outbound trips leaving Boston before 3:00 P.M. or after 7:00 P.M. stop at South

Station before Park Square. Trips leaving between 3:00 and 7:00 P.M. that serve both South Station and Park Square stop at Park Square first.

Scheduled running times between Sagamore and South Station vary according to the number of intermediate stops served, and expected traffic conditions. In the A.M. peak, scheduled times for non-stop trips from Sagamore to South Station increase gradually from 60 minutes to 80. Ten minutes additional is allowed to Park Square. Outbound non-stop scheduled times from South Station to Sagamore range from 65 to 70 minutes, with 10 minutes more from Park Square.

This route has much more frequent service than the Bonanza routes discussed above, but the Sagamore stop is further from most of the population of the town of Bourne. The winter 1996 schedule provided 27 inbound and 25 outbound trips per day between Sagamore and downtown Boston. Park Square was served by 21 of the inbound trips and 19 of the outbounds. Eleven of the inbound trips and nine of the outbounds between Sagamore and downtown Boston ran through to or from Logan Airport, via the Ted Williams Tunnel. Another four inbound and five outbound trips ran between Sagamore and the airport without serving downtown Boston. Most Sagamore trips ran through to or from Hyannis or beyond, and also served a park-and-ride lot in Barnstable.

Fourteen of the inbound trips stopping at Sagamore had scheduled Boston arrivals between 6:30 and 9:30 A.M., (the definition of A.M. peak for present commuter rail service) with headways as short as 5 to 10 minutes. Ten of the outbound trips left Boston between 4:00 and 6:30 p.m., mostly at intervals of 10 to 15 minutes. The number of outbound P.M. peak trips was the same in 1996 as in 1990, but inbound A.M. peak service included an increase of one trip. In addition, the 1996 schedule included three downtown Boston arrivals earlier than 6:30 A.M., whereas the 1990 schedule had none. Because of the multiple stops on the route, ridership at Sagamore alone cannot be estimated from the level of service there.

On non-summer Saturdays and Sundays, there are 15 round trips between Sagamore and South Station, with all but one of the inbounds also serving Park Square. Eleven of the South Station trips each way also serve the airport, and four additional round trips serve the airport but not downtown Boston. Service is increased slightly from June through Labor Day.

The 1990 Census figures show 63 work trips by Bourne residents via bus to downtown Boston and 40 to other parts of Boston, but none to Cambridge, for a total of 103. This represents a 31% bus share of the 334 total Boston and Cambridge work trips from Bourne. These would include boardings at the Bonanza Buzzards Bay, Trowbridge Road, and Otis AFB stops and the P&B Sagamore stop. The Census total would average out to only six passengers per bus at 1990 service levels, but the buses that serve Bourne also serve several other towns both directly and indirectly.

## ***Middleborough and Rochester***

A Bourne commuter rail extension would also pass through the towns of Middleborough and Rochester. For reasons discussed elsewhere in this report, however, the extension would have no station in either town other than the Middleborough/Lakeville Old Colony terminal. The latter location would be more convenient for Middleborough residents than any station on the extension, so Middleborough is not included in the market area of the extension. Rochester adjoins Wareham, and is treated below as a contiguous town.

### **Contiguous Towns**

Towns contiguous to those directly on the route of a Bourne extension are Lakeville, Carver, Plymouth, Marion, Sandwich, and Falmouth. As noted above, Rochester is also treated here as a contiguous town. The most densely populated sections of Plymouth will be much closer to stations on the Plymouth commuter rail line, scheduled to open in September 1997, than they would be to any location on a Bourne commuter rail line. The access distances from homes in Lakeville to the planned Middleborough/Lakeville station would be much shorter than those to any other station on a Bourne extension.

Carver has relatively low work-trip orientation to Boston and Cambridge (a total of 242 trips according to 1990 Census data.) The population of the town is most heavily concentrated in the northern section, and would be closer to stations on the Middleborough/Lakeville and Plymouth lines than to any station on a Bourne extension. For these reasons, Plymouth, Lakeville, and Carver can all be disregarded as potential sources of ridership for a Bourne extension. Existing conditions in the remaining contiguous towns are discussed below.

Mattapoisett is contiguous to Rochester, which would not have a station. Mattapoisett would, however, have good highway access to a station in Wareham via Routes I-195 or U.S. 6, but has indirect highway access to Boston. For these reasons, Mattapoisett is grouped with the contiguous towns.

### ***Rochester***

Rochester, which borders on Wareham, is not served directly by any commuter bus lines. The nearest lines are those serving Wareham (discussed above), Middleborough, and New Bedford.

According to 1990 U.S. Census Journey-to-Work figures, 21 Rochester residents traveled to work in downtown Boston by bus, but the routes used were not specified. Another five Rochester residents made work trips to downtown Boston by unspecified commuter rail lines in 1990. (The 1993 commuter rail survey included two responses from Rochester residents who worked in downtown Boston. One drove to Stoughton and the other to Mansfield to

board.) No transit trips were made from Rochester to other parts of Boston, and no work trips from Rochester to Cambridge by any mode were reported. The transit ridership represented 40% of the total 65 work trips from Rochester to downtown Boston, and 28% of the total of 93 to all of Boston.

### ***Marion and Mattapoisett***

Marion, which borders on Wareham, and Mattapoisett, which is the next town beyond Marion, are not served directly by any commuter bus lines. The 1990 Census figures show 19 work trips by Marion residents via bus to downtown Boston and 7 to other parts of Boston, but none to Cambridge, for a total of 26. This was a 38% share of the total 69 work trips to Boston and Cambridge from Marion.

From Mattapoisett there were 15 work trips by bus to downtown Boston and 24 to other parts of Boston, but none to Cambridge, for a total of 39. This was a 51% share of the total 77 work trips to Boston and Cambridge from the town.

The figures do not show which bus routes were used for trips from Marion or Mattapoisett, but the most likely possibilities are routes serving Fairhaven or Wareham. There were no work trips to Boston from Marion or Mattapoisett by other transit modes.

Wareham bus service is described above. The Fairhaven bus route is operated by American Eagle Motor Coach. On weekdays, there are 17 inbound and 18 outbound trips between Fairhaven and South Station. This includes nine inbound arrivals between 6:30 and 9:30 A.M., and 7 outbound departures between 4:00 and 6:30 P.M. The Fairhaven stop is on Sycamore street, about one half mile from an exit off I-195. Commuter parking is available there in a lot owned by the bus company.

The peak-period scheduled running time from Fairhaven to Boston ranges from one hour, 25 minutes to one hour, 55 minutes inbound; most outbound peak trips are scheduled for one hour, 30 minutes. These times are substantially longer than the 60 minutes scheduled from Wareham to Boston, but the Fairhaven route provides many more departures. Marion residents will also be able to use the planned New Bedford commuter rail line.

### ***Falmouth***

Falmouth, which includes Woods Hole, is the only town to the south of, and directly contiguous to, Bourne. All trips on the Bonanza Bus Lines route serving Bourne continue through at least as far as Falmouth. That is, 11 round trips per weekday, including three inbound arrivals in Boston in the A.M. peak and four outbound departures in the P.M. peak. The main Falmouth stop is at the former railroad station on Depot Avenue near the center of the business district. (This



station is 13.8 miles from Buzzards Bay Station via rail). The scheduled bus time between Falmouth and Bourne is 20 minutes in each direction, resulting in a total of 85 to 90 minutes from Falmouth to Boston.

The Falmouth Station has marked parking spaces for 54 cars, with additional capacity in unmarked spaces. An April 1996 count found 58 cars parked there at 3:30 P.M., but some may have been left by passengers of bus routes other than the one to Boston, or by patrons of nearby businesses.

All of the outbound trips continue through to the Steamship Authority piers at Woods Hole. (This location was 17.4 rail miles from Buzzards Bay, but the rail line now ends at Falmouth, and is out of service beyond North Falmouth.) The additional scheduled time between Woods Hole and Falmouth is ten minutes on most trips. All of the inbound trips except for the first two A.M. peak departures originate at Woods Hole. This service is operated mainly as a connection for ferry service to Martha's Vineyard rather than for local Woods Hole traffic. There is no other through bus service to Boston from any points in Falmouth.

From the Otis Air Force Base stop in Bourne to downtown Falmouth, buses operate over Route 28, which is a limited-access highway for most of the way. The bus route segment from Falmouth to Woods Hole uses a local road.

The 1990 Census figures show 29 work trips by Falmouth residents via bus to downtown Boston and 25 to other parts of Boston, but none to Cambridge, for a total of 54. This was a 14% share of the total 392 Boston and Cambridge work trips from Falmouth. The much lower bus share at Falmouth compared to that at Bourne (31%) reflects the higher combined level of service provided by the three routes in Bourne, as well as constrained parking in Falmouth.

There has been an increase of one outbound P.M. peak trip on the Falmouth/Woods Hole route between 1990 and 1996, suggesting that ridership may have increased also.

The Census figures do not show any commuter rail trips from Falmouth to Boston. The 1993 commuter rail survey had one response for such a trip, from a passenger who drove to Route 128 Station to board. The Census figures show 10 work trips from Falmouth to Boston using rapid transit. The route was not specified, but these trips were most likely made by driving to Braintree or Quincy Adams on the Red Line.

### ***Sandwich***

The town of Sandwich adjoins Bourne to the east. Buses on the P&B Hyannis route pass through Sandwich on the Mid-Cape Highway (U.S. Route 6) but make no stops within the town. For Sandwich residents, the nearest stop for commuter buses to Boston is the park-and-ride lot at Sagamore Circle, discussed in the

Bourne service section above. The 1990 Census figures show 24 work trips by Sandwich residents via bus to downtown Boston, 27 to other parts of Boston, and 5 to Cambridge, for a total of 56. This was a 14% share of the total 398 Boston and Cambridge work trips from Sandwich. This relatively low share reflects the lack of a bus stop directly within the town. No other transit trips from Sandwich were reported. The 1993 commuter rail survey had one response from a passenger traveling to Boston by driving to Attleboro Station, but this was an infrequent, non-work trip.

### **Other Cape Cod Points**

As discussed in Chapter 4, nearly one third of the ridership on a Bourne extension would originate in Barnstable County towns other than Bourne, Falmouth, or Sandwich. For this reason, existing public transportation service to other Cape Cod points is described below.

#### ***Mashpee***

The town of Mashpee adjoins Falmouth to the east. There is no direct bus service from Mashpee to Boston. The closest stop for most parts of the town would be the Bonanza Bus Lines station in Falmouth. The 1990 Census figures show 14 work trips by Mashpee residents via bus to downtown Boston but none to other parts of Boston or to Cambridge. This was a 10% share of the total 134 Boston and Cambridge work trips from Mashpee. In addition, the Census shows five work trips from Mashpee to downtown Boston by commuter rail. The 1993 commuter rail survey had no responses from Mashpee residents, however.

#### ***Barnstable***

The town of Barnstable is to the east of Sandwich. Hyannis is part of Barnstable. Bus service to Hyannis is provided by the same Plymouth & Brockton route that serves Sagamore Circle. From the Sagamore Bridge, buses follow Routes 6 and 132 to the Route 28 rotary in Barnstable, then local roads to the Hyannis bus terminal. In addition to the terminal, all buses on this route stop at a park-and-ride lot at the junction of Routes 6 and 132 about four miles west of the terminal. The level of service at these two stops is the same as that described above for the Sagamore Circle stop, except that the first inbound morning trip (arriving in Boston at 5:40 A.M.) originates at Sagamore.

The scheduled running time between Sagamore and Hyannis is 25 minutes on almost all trips in either direction. The time from Sagamore to the Barnstable park-and-ride lot is 15 minutes. As noted above, peak-period scheduled times from Sagamore to South Station range from 60 to 80 minutes inbound, and from 65 to 70 outbound. This results in scheduled times from Hyannis to Boston ranging from one hour, 25 minutes to one hour, 45 minutes.

The 1990 Census figures show 75 work trips by Barnstable residents via bus to downtown Boston, and 9 to other parts of Boston, but none to Cambridge, for a total of 84. Presumably, most of these passengers boarded at one of the stops within the town. Despite the frequent service, this was only a 16 percent share of the total 523 Boston and Cambridge work trips from Barnstable.

The Census totals from Barnstable would have accounted for an average of only 6.5 bus passengers per peak trip at 1990 service levels. The Barnstable stops also serve passengers from towns further east, which have very limited direct service. Hyannis buses would also have picked up passengers at Sagamore. In both 1990 and 1996, a few peak Hyannis trips served a park-and-ride lot in the town of Rockland. In 1996, five inbound A.M. peak trips and one outbound P.M. peak trip served the park-and-ride lot in North Plymouth.

In addition to the bus trips, the 1990 Census showed 12 work trips from Barnstable to Boston (outside downtown) by commuter rail. The 1993 survey did not have any responses from trips originating in Barnstable or further along the Cape, however. The Census did not show any work trips from Barnstable to Boston by other transit modes.

### ***Beyond Hyannis***

Hyannis is the furthest point on Cape Cod served by most buses from Boston. In non-summer months, two round trips a day continue through to Provincetown, but they are not scheduled to serve Boston work trips. In summer months, more trips are run through, but they are also generally unsuitable for Boston commuting.

The first town east of Barnstable is Yarmouth. The Census figures show 33 work trips by Yarmouth residents via bus to downtown Boston, and 6 to other parts of Boston, but none to Cambridge, for a total of 39. This represents a 40% bus share of the 99 total Boston and Cambridge work trips from Yarmouth, despite the lack of a bus stop with peak-period service directly in the town. Most of these passengers probably used the Hyannis terminal or Barnstable park-and-ride. The Census figures also show seven work trips from Yarmouth to downtown Boston by rapid transit (probably by driving to the Red Line) but none by commuter rail. The 1993 survey also had no responses from Yarmouth origins.

The second town east of Barnstable is Dennis. The Census figures show only five work trips by Dennis residents via bus to downtown Boston, and none to other parts of Boston or to Cambridge. This was a 10% share of the total 55 Boston and Cambridge work trips from Dennis. The five trips were probably made via Hyannis or the Barnstable park-and-ride. No other mass transit trips from Dennis were shown, and the commuter rail survey showed no Dennis origins.

Census figures show a total of 242 work trips per day to Boston or Cambridge from the remaining eight Cape Cod towns beyond Dennis. Of these trips, 38, or 16% were carried on express buses, despite the lack of direct service.

## **APPENDIX B - ANALYSIS OF ALTERNATIVE ALIGNMENTS BETWEEN MIDDLEBOROUGH AND BOSTON**

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For the past 30 years, the only through rail link between Middleborough and Boston has been a line through Taunton to Attleboro, connecting there with the MBTA's Attleboro commuter rail line. Other rail lines, now abandoned, once provided alternate connections to the Attleboro line from Taunton at Mansfield and at Canton Junction, via the Stoughton Line. In conjunction with the planned Fall River/New Bedford commuter rail extension, the MBTA is planning to construct a new cutoff between the Middleborough-Attleboro line and the Attleboro-Boston line.

Running times for Bourne trains between Middleborough and Boston via the Middleborough/Lakeville commuter rail line and via alternative routes are examined in the following sub-sections. The conclusion is that the Middleborough/Lakeville line is the best alternative for this service.

### **Middleborough-Attleboro Line**

Until completion of the Old Colony Middleborough/Lakeville line in 1997, the only through rail route between Middleborough and Boston will be via the line through Taunton to Attleboro (used by summer Amtrak service) and the Attleboro commuter rail line from there to South Station. Current track layout would require that trains using this combination of lines reverse direction at Attleboro.

The distance from the Middleborough/Lakeville Station to Attleboro Station is 21.6 miles. Historically, most sections of this line have had maximum speed limits of 50 m.p.h., and there have been restrictions for curves and grade crossings at several locations. With the past maximum speed limits, the fastest possible running time from Middleborough/Lakeville to Attleboro would be 35 minutes. In order for the total time to South Station to be less than the 58 minutes via the Middleborough/Lakeville line, the combined time to reverse direction at Attleboro and run from there the South Station would have to be less than 23 minutes.

Speed limits between Attleboro and Boston are currently 95 to 100 m.p.h. for most of the route south of Back Bay, with some 60 m.p.h. and 85 m.p.h. segments. The fastest time for a train to run from Attleboro to South Station (31.9 miles) with no intermediate stops except Back Bay would theoretically be about 25 minutes. At present, no commuter trains are scheduled to make such trips. The fastest trains from Attleboro to Boston, stopping only at Mansfield and Back Bay, are scheduled for 39 to 40 minutes. Omitting the Mansfield stop would reduce this by only about three minutes. Therefore, even disregarding the time to reverse direction at Attleboro, the likely running time from Middleborough/Lakeville to South Station would be significantly longer via Attleboro than via

the Middleborough/Lakeville Line. Furthermore, the Attleboro routing would add 18 miles, or 51%, to the distance from Middleborough/Lakeville to South Station compared to the direct routing. For these reasons, this alternative is not examined further in this study.

### **New Attleboro Cutoff Line**

In conjunction with the planned New Bedford/Fall River commuter rail extension, the MBTA plans to build a new rail line connecting the Attleboro-Middleborough route near the border of Attleboro and Norton with the present Attleboro commuter rail line near the border of Attleboro and Mansfield. The new cutoff would follow the right-of-way of an existing electric power line.

The length of this new cutoff would be about 2.5 miles. This would replace about five miles of running on the existing lines, and would avoid the reverse of train direction required at Attleboro Station. With a top speed of 79 m.p.h. and no delays at the junctions of the cutoff and the existing lines, total running time compared to a routing via Attleboro Station would be reduced by about 4.5 minutes, exclusive of reversing time. This would theoretically allow a total running time from Middleborough/Lakeville to South Station of 55.5 minutes, or 2.5 minutes faster than the time via the Middleborough/Lakeville line. Because of the amount of other traffic routed via the Attleboro line, however, it is very unlikely that times as fast as this would actually be scheduled. This route would still be 15.5 miles longer than the routing via the Middleborough/Lakeville line. For these reasons, combined with the uncertainty as to whether the cutoff will be built, this alternative is not examined further in this study.

### **Stoughton Line**

The Stoughton commuter rail line formerly continued through Easton and Raynham to a connection with the Middleborough-Attleboro line at Whittenton Junction in Taunton. This line was abandoned south of Easton in 1966 and north of Easton in 1976. Most of the right-of-way is owned by the MBTA, but much of the track has been removed and the remainder is unusable. The MBTA has examined this line as a possible routing for New Bedford/Fall River service, but has concluded that re-opening it would involve serious environmental impacts. (The roadbed crosses Hockomock Swamp, also known as Great Cedar Swamp, on the border of Raynham and Easton.)

Historically, this line had maximum speed limits of 50 to 55 m.p.h., with some slower sections at sharp curves. With all sections restored to past maximum speeds, the fastest theoretical time between Taunton and South Station via this route with no intermediate stops except Back Bay would be about 45 minutes. An additional 20 minutes of running time would be required between Middleborough/Lakeville and Taunton, making a total of 65 minutes from Middleborough/Lakeville to South Station. This would be seven minutes longer

than the time via the Middleborough/Lakeville commuter rail line. As with other options, it is unlikely that the theoretical minimum time via the Stoughton alternative could actually be scheduled. The total length of this route would be 47.0 miles, or 11.5 miles longer than the most direct route.

### **Taunton Branch**

Another rail line known as the Taunton Branch formerly connected the Attleboro line at Mansfield Station with the Middleborough-Attleboro route at Whittenton Junction. The connection at Mansfield was removed in 1955 because of a highway construction project, and the remainder of the line was abandoned in 1966. The current ownership status of the right-of-way of this line is unclear, and restoration of a connection at Mansfield would involve some engineering problems.

The historical speed limit on this branch was 55 m.p.h. In combination with the Attleboro line north of Mansfield, it formed the fastest route between Taunton and Boston. With all sections restored to past maximum speeds, the fastest theoretical time between Taunton and South Station via this route with no intermediate stops except Back Bay would be about 37 minutes. An additional 20 minutes of running time would be required between Middleborough/Lakeville and Taunton, making a total of 57 minutes from Middleborough/Lakeville to South Station. This would be one minute less than the time via the Middleborough/Lakeville commuter rail line. As with other options, it is unlikely that the theoretical minimum time via the Taunton Branch could actually be achieved. The total length of this route would be 46.9 miles, or 11.4 miles longer than the most direct route.





## **APPENDIX C - ANALYSIS OF ALTERNATIVE STATION LOCATIONS**

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### **Importance of Highway Access in Station Site Selection**

In the 1993 commuter rail survey, among passengers who reported walking as their mode of access to the outer boarding station, 96 percent reported access times of 20 minutes or less. At typical walking speeds, this would mean that most walk-ins had access distances of under one mile. As will be seen from the discussion below, the number of potential users of a Bourne commuter rail extension who would live within one mile of a station would be small. Trip origins would also be too widely scattered to allow cost-effective feeder services. Therefore, in planning stations for the extension, highway access and parking availability would be of critical importance.

As discussed in Chapter 4, home-to-work trips ending in either Boston or Cambridge account for 85% of the inbound weekday ridership on the existing commuter rail lines terminating at South Station. Work trips to the Boston Central Business District alone account for 74% of the ridership. It is reasonable to assume that Boston and Cambridge work trips would also be the primary market for a Bourne commuter rail extension. Journey-to-Work figures from the 1990 Census show that under two percent of the residents of any town in the probable attraction area of a Bourne extension work in Boston Proper, and that under three percent are employed in all of Boston and Cambridge combined.

On average, towns in the Bourne extension service area have much larger land areas and more dispersed population than those along existing commuter rail lines. The number of Boston and Cambridge workers per square mile in 1990 averaged under 10 for every town on or in the Bourne service area except Wareham, where the average was 13.3. In Bourne the overall average was 8.0. Deducting the area occupied by military reservations would raise this only to under 25.

A circle with a radius of one mile centered on a rail station, representing the walk-in attraction area, would have a total area of about three square miles. Drawn in Wareham, such a circle would have enclosed an average of 42 Boston or Cambridge workers in 1990. Drawn in Bourne, the figure would have been under 65; because of the proximity of the rail line to the Cape Cod Canal and other bodies of water less than half of the area of the circle would be accessible by walking. Not all of these workers would have chosen to use commuter rail service if it were available. These calculations do not take into account variations in densities of Boston and Cambridge workers within towns, but nevertheless indicate very limited walk-in potential at any individual station site.

### **Buzzards Bay Station Location**

The Buzzards Bay Secondary track passes through only one half mile of the town of Bourne between the border of Wareham at Buttermilk Bay and the north side of the Cape Cod Canal. This leaves little choice for a station site at Buzzards Bay other than the former New Haven Railroad station location on Main Street at Academy Drive. Any change in the station site would be so slight that it would not affect the conclusions of this study.

Seasonal Amtrak service to Hyannis uses the old Buzzards Bay Station. The former waiting room is maintained as a tourist information center by the local chamber of commerce. There is a long paved platform in good condition, and a wheelchair access ramp of a design similar to those at present commuter rail stations. There are paved parking spaces for about 60 cars and unpaved spaces for about 40 more. These lots are little-used in non-summer months, but are filled by visitors to the downtown shops and the recreational area along the canal in the summer. Additional land around the station formerly occupied by rail yards is now planted with grass, but could potentially be replaced by commuter parking. An abandoned lumber yard near the station is for sale, and might also be used for parking expansion.

Among the disadvantages of the Buzzards Bay Station site are that it would be within walking distance of a relatively small part of the town of Bourne, and that it is no longer directly on a major through highway route to Boston. Traffic going to Boston from most of the Cape would have to cross one of the canal bridges in order to reach Buzzards Bay Station, but these bridges are the major traffic bottlenecks on the Cape. There would be much less incentive for drivers to divert to Buzzards Bay than to stations south of the canal. For these reasons, station sites in Bourne on the south side of the canal have also been analyzed in this study.

### **Locations of Existing and Former Stations Between Buzzards Bay and Middleborough/Lakeville**

#### ***Wareham and Onset***

The current seasonal Amtrak service on the Buzzards Bay Secondary includes one intermediate stop in Wareham, near the town center, 5.4 miles from Buzzards Bay and 13.7 from Middleborough/Lakeville. This location has limited passenger amenities. There is a large wooden shelter, comparable in size to shelters on the MBTA Needham Line. It is open on three sides, with restrooms on the fourth side. There is no ticket office or closed waiting room. An old station platform here was about 800 feet long. The sections nearest the shelter were re-paved in the 1980s, but other parts are in fair to poor condition. There is no permanent wheelchair access ramp. As at Buzzards Bay, a full high-level

platform would be required for compatibility with the Old Colony operating plan.

There are paved parking lots along the Wareham Station platform on both sides of the shelter. One lot has 69 spaces, designated as commuter parking, and used mostly by express bus passengers. (An April 1996 count found 47 empty spaces there at mid-day.) The other lot has 14 spaces, with a two-hour limit. Additional handicapped parking is available beyond the two-hour lot. The station area is bounded to the north by the Agawam River, and to the south by Wareham's main business district. This would prevent any significant expansion of surface parking capacity at this location.

When year-round rail passenger service between Cape Cod and Boston was last operated in 1959, all trains stopped at Wareham, at the same location as the Amtrak station. All trains also made another stop at Onset Station at Depot Street in Wareham, 15.7 miles from Middleborough/Lakeville and two miles southeast of Wareham Station. These were the only two intermediate stops made between Buzzards Bay and Middleborough at that time. The former station buildings at Onset are now used by an auto repair and used car sales business. There are no remaining traces of the platform. There is some vacant land in the vicinity of this site that might be suitable for a future station.

#### *Other Stations in Wareham and Middleborough*

Several other stations between Buzzards Bay and Middleborough existed at one time, but all of them had been discontinued prior to 1959 because of low demand. These stations dated from an era when rail passenger service was used for short local trips as well as for longer distance commuting, and when walking was the main available mode of station access. Few traces now remain of any of them. Future rail service would have a much smaller number of stations, but examination of past station sites is useful for gaining a rough idea of where some of these future stations might be located. A map of former station location in Wareham appears on page 74.

Three stations north of Wareham Station were closed in a service cutback in 1938. Two of these were in Middleborough. These were Rock (at Miller Street) and South Middleborough (at Spruce Street). They would be about 3.9 and 6.1 miles, respectively, from Middleborough/Lakeville. The third of these was Tremont in Wareham, near Pierceville Road, about 10 miles from Middleborough/Lakeville.

Two other Wareham stations had been discontinued even earlier. South Wareham, (at Station Street) closed around 1930. Parker Mills (near Main and Elm Streets) closed about 1925. They would be about 11.6, and 12.8 miles, respectively, from Middleborough/Lakeville.

# **T** BOURNE COMMUTER RAIL

Feasibility Study

## **FORMER RAILROAD PASSENGER STATION LOCATIONS IN WAREHAM**



### Proximity of Potential Station Sites to Major Highways

The Buzzards Bay Secondary Track runs within one mile of Route I-495 between Middleborough/Lakeville and Wareham; and within two miles of state Route 25 between Wareham and Buzzards Bay. These are both limited-access highways. The same corridor is also served by the older state Route 28 and U.S. Route 6. Connections to the rail line from any of these highways at most points would require some use of local roads. The nearest points on the railroad to most of the exits on Route 25 and Route 495 via existing roads are at or near former station sites listed above.

#### *Wareham and Onset*

The present Amtrak Wareham Station site is about three miles from the Route 25 East Wareham exit via Route 6. The former Onset station site is about one mile from the same exit. The present Buzzards Bay Station site is 1.6 miles from the Route 25 interchange at the north end of the Bourne Bridge. Traffic heading north on Route 25 from points on the Cape passes the Buzzards Bay exit 4.5 miles before reaching the East Wareham exit. There is no other access to Route 25 between Buzzards Bay and East Wareham. Therefore, with adequate parking capacity at Buzzards Bay, neither a Wareham Station nor an Onset Station would be likely to divert much additional traffic off Route 25. For this reason, proximity to Route 25 need not be a factor in comparing these two station sites.

#### *Parker Mills and South Wareham*

The interchange of Routes 25 and 495 is about two road miles from the former Parker Mills Station site, and three miles from either the present Wareham Station or the former South Wareham Station site. Traffic reaching this exit on Route 25 from the south would have to pass the East Wareham exit first, and unless entering there would also pass the Buzzards Bay exit. Like Wareham and Onset, stations at Parker Mills or South Wareham would have little potential for attracting traffic off Route 25 that could not be better served by a Buzzards Bay station.

The present express bus parking lot at the Mill Pond Diner in Wareham adjoins the Parker Mills station site. This location has more service than the downtown Wareham Station site, but this is more because of operating efficiency for the buses than because of convenience of access for passengers.

Route 195 crosses the rail line one third of a mile from the former South Wareham Station site, but the nearest exit from the highway is its interchange with Route 28. This would make the driving distance from Route 195 to South Wareham about 1.7 miles. The Parker Mills site is about one road mile from Route 195. Towns that would be linked to the Bourne rail extension via Route 195, (and also by U.S. Route 6 which runs parallel with it) are Marion

Mattapoisett, and Fairhaven. Of these, only Marion would be closer to the Bourne line than to the planned New Bedford commuter rail extension. In 1990 only 1.5% of Marion residents, or a total of 69, worked in Boston and none in Cambridge.

### ***Tremont***

Route 495 connects in Wareham with state Route 58 at Exit 2, near the Rochester town line. The shortest distance to the rail line from this exit is 1.3 road miles via Route 58 and County Road. There was never a station at this location, and there does not appear to be sufficient undeveloped space suitable for building one. The former Tremont Station site is about 1.9 road miles from Exit 2.

Tremont would be the nearest feasible station site for most Rochester residents. In 1990, 1.7% of Rochester residents, or a total of 93, worked in Boston, and none in Cambridge. Route 58 would also provide good access to Tremont from the town of Carver. Much of the population of that town is concentrated at the north end, however, and would have about equally convenient access to the Plymouth commuter rail line. In 1990, 2.3% of Carver residents worked in Boston or Cambridge, or a total of 242.

### ***South Middleborough and Rock***

Exit 3 of Route 495 is in Middleborough, about 1.8 miles from the Rock Station site via Route 28 and Miller Street. It is also about 2.5 miles from the South Middleborough Station site via Route 28, but access to this site would involve doubling back for the entire distance. Rather than do that, drivers would be likely to remain on Route 495 for the additional 4.5 miles from Exit 3 to Exit 4, adjacent to the new Middleborough/Lakeville Station if parking capacity was available there. The South Middleborough site could also be accessed by driving 4.7 miles from Exit 2 on Routes 58 and 28, but this exit is less than two miles from the Tremont site.

The Rock and South Middleborough sites are both located in sparsely populated sections of the town. Some new housing is being built in these sections, but the potential for further growth may be limited because of wetlands. Access from other towns to the west is cut off by a series of long ponds. The 1990 Census figures show 68 work trips to Boston or Cambridge from the Rock Village block group, and 28 from the South Middleborough block group. Many of the homes in these block groups are beyond reasonable walking distance of either station site. For these reasons, this analysis assumes that neither Rock Village nor South Middleborough would have a station on a Bourne commuter rail extension.

## **Conclusion**

As indicated by the discussion above, the only likely intermediate station sites between Buzzards Bay and Middleborough/Lakeville in the foreseeable future would be in the town of Wareham. In 1990, there were significantly more people with Boston and Cambridge work locations residing in Wareham (507) than in Bourne (334). Therefore, it is reasonable to assume that a Bourne commuter rail extension would include at least one station in Wareham. Because of the highway layout relative to the rail line, there would be substantial overlap in the markets served by hypothetical station sites in the town. If only one station is to be provided, the most central location for it would be the present Amtrak station site. This site would also have the least negative impact on running times of any station site in the town because of unavoidable speed restrictions at the grade crossing of Route 6. Parking capacity at this site would be relatively limited, however.

## **Possible Station Locations on Hyannis Line**

Operation of commuter service further east than Sagamore is not discussed in detail in this report, because preliminary analysis indicated that it would be most efficient to intercept traffic close to the canal bridges. In the event that sites with adequate parking for this strategy cannot be obtained, however, dispersal of boardings over a greater number of sites could be re-evaluated. Operation of summer service to points east of Sagamore, especially on weekends, could also provide a source of additional ridership for the line. For these reasons, an inventory of past and present station sites throughout the Hyannis line is included here.

The Amtrak summer rail service to Hyannis serves two intermediate stops between Buzzards Bay and Hyannis. These are Sandwich, (at Jarves Street in that town) and West Barnstable (at Meeting House Way). These stations are 7.9 and 15.1 miles from Buzzards Bay. The same station sites were used by Boston passenger trains until 1959, and by summer-only New York-Cape Cod service until 1964. Hyannis Station is now at Main Street, whereas the historical station location was 0.7 miles north of this at the Route 28 crossing.

Several other stations existed in the past between Buzzards Bay and Hyannis, but most were used only in summer months, and had minimal passenger facilities. Starting from Buzzards Bay, the first of these was Bourne, at Perry Road, which formerly crossed the canal on a drawbridge. Recent residential development would preclude future use of this site for a station. A site closer to the present Bourne Bridge would be preferable in any case. The second station, Bournedale, near Long Boat Road, likewise served a former canal crossing, and is also in the midst of a recent housing development. Sagamore Station was off Pleasant Street about one half mile east of the Sagamore Bridge. A station in the same general vicinity could intercept traffic going to the bridge. More parking capacity could

be provided by relocating the station to the Canal Electric complex on the border of Bourne and Sandwich, however.

In addition to Sandwich Station, the town of Sandwich had an East Sandwich Station, 2.8 miles further east, at the Route 6A crossing. Current land use around this site would probably make it unsuitable as a future station location. (The Bourne, Sagamore and East Sandwich stations were all discontinued in 1938; Bournedale was discontinued around 1930).

In addition to West Barnstable and Hyannis, the town of Barnstable had a downtown station at Railroad Avenue, off Route 6A. This station was 3.6 miles from West Barnstable and 4.9 from Hyannis. (It was discontinued about 1950.) The West Barnstable Station has convenient highway access from more points than the Barnstable Station site. If only one of the two were served, West Barnstable would be the better choice.

Between West Barnstable and Hyannis the rail line follows an indirect route, taking 9.2 miles to cover the distance. The shortest driving distance between the two stations is about seven miles. About two miles of the rail line is within the town of Yarmouth. Until 1964 there was a station in that town at Cross Street. This was is the location of the junction between the Hyannis Secondary Track and the South Dennis Secondary Track. This site would have good access from both Route 6A and Route 6, and would be a good location for intercepting traffic bound for Boston from towns east of Barnstable.



## **APPENDIX D - RIDERSHIP ESTIMATION METHODOLOGY**

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Chapter 4 of this report describes the travel markets expected to be served by a Bourne extension, and summarizes the predicted ridership from these markets. This appendix provides further details in the methods that were used in estimating ridership.

### **Estimated Extension Share of Boston Proper Work-Trip Market at 1990 Travel Levels**

#### ***On-Line Towns***

##### **Market Shares for Present On-Line Towns**

The share of the Boston Proper work-trip market captured by the existing commuter rail lines varies widely among the cities and towns served. These differences can be attributed to many underlying causes, but are influenced strongly by the range of options available to residents of these communities. In general, among cities and towns with direct commuter rail service, the highest rail market shares are found where average rail travel speeds are highest, highway access to Boston is poorest, and no other direct transit alternatives are available. Rail typically also attracts higher market shares as travel distance from Boston increases.

Wareham and Bourne, the two towns that would be served directly by a Bourne extension, are both farther from Boston than most towns on the existing commuter rail system. Most highway trips from Wareham or Bourne to Boston are made in part via the heavily congested Southeast Expressway. These conditions would be conducive to high market share for rail service to these towns. Both towns also have well established private-carrier express bus service to Boston, however, which would decrease the rail market potential. In the past two decades when rail passenger service to Boston has been re-established after an absence of several years, bus companies serving the same corridors have usually reduced their service frequency, but few routes have been eliminated completely. It is probable, therefore, that some bus service to Boston from Wareham and Bourne would continue to operate in competition with a rail extension.

According to 1990 Census Journey-to-Work tabulations, the highest rail share of Boston Proper work trips any city or town with direct MBTA commuter rail service was 76%, from Attleboro. (Results of the 1993 commuter rail survey are consistent with this finding). The rail line serving Attleboro has the highest average train speeds of any line in the system, and two of the largest park-and-ride lots in the system are located within the city. There is currently no through bus service from Attleboro to Boston, and the only such service operated in the past used older highways and was not time-competitive with rail. The outer

segments of the most direct limited-access highway route from Attleboro to Boston are generally free-flowing, but the final approach to Boston is via the Southeast Expressway.

The only other towns with a combination of conditions similarly favorable to commuter rail are Mansfield, Sharon, and Canton, all of which are also on the Attleboro route. According to the Census figures, rail shares of Boston work trips from these towns in 1990 were 63%, 53%, and 43%, respectively. Providence, Rhode Island, which is on the same route but is also served by express buses had a rail share of about 55%. The only town on a route other than the Attleboro Line with a rail share in excess of 60% was Franklin, at 62%.

At the opposite extreme, commuter rail attracts very low shares of Boston Proper work trips from some cities and towns with direct service. Several of the communities in fare zones 1B, 1, and 2 had rail market shares of under 5% in 1990. These included Malden, Cambridge, Chelsea, Medford, Belmont, and Lynn. Newton and Waltham each had rail shares of between 5% and 7%. All of these cities and towns were served by a variety of other MBTA-operated transit modes.

In most communities with stations at least 25 miles from North or South Station, commuter rail captures at least 25% of total Boston work trips, according to Census figures. The only exceptions in 1990 were Lawrence, Leominster, and Fitchburg. The stations in these cities are respectively 26.0, 45.3, and 49.6 rail miles from North Station. The Census results for all three were expanded from very small samples, and are probably low. Based on the 1993 survey results, the rail share from Lawrence is around 14%, but the shares from Leominster and Fitchburg are both around 25%. Lawrence has express bus service to Boston in addition to rail service, but Fitchburg and Leominster do not. Average travel speeds to Boston from all three stations are lower than the potential speed from Buzzards Bay (29 to 32 m.p.h. versus 39 to 40 m.p.h.).

#### Estimated Demand from Wareham and Bourne

A commuter rail extension with an 82-minute running time from Buzzards Bay to South Station (as described in Chapter 3) would have an overall average speed of 39.9 m.p.h. between these points. This would be the same as the present average A.M. peak scheduled speed between Attleboro Station and South Station. (The average speed from Wareham Station would be slightly lower.) The only Boston stop for Bourne service would be South Station, but all Attleboro trains stop at both South Station and Back Bay and a few also stop at Ruggles. The Bourne service would also have express bus competition, which Attleboro service does not. For these reasons, the 76% commuter rail share at Attleboro was assumed to represent the upper bound on the share of work trips to Boston Proper from Bourne and Wareham that could be captured by a Bourne extension with no bus competition. With continued bus service, 76% was assumed to

represent the maximum combined rail and bus share of Boston Proper work trips from Bourne and Wareham. Of this, the bus share was assumed to be about half its present level. The lower-bound rail share of Boston Proper work trips from Bourne and Wareham was assumed to be 25%, regardless of bus competition.

The 1990 Census figures show a total of 148 work trips to Boston Proper from Bourne and 282 from Wareham, or a combined total of 430. A 76% share of this would be 326 trips, of which the rail component alone was estimated to be 280. At 25%, the minimum rail share of this market would be 108. The mid-point between 108 and 280 would be 194.

### ***Off-Line Towns***

#### **Market Shares for Present Off-Line Towns**

Commuter rail typically captures smaller shares of trips from cities and towns without stations than from those with direct service. According to the 1990 Census figures, the only cities or town in Massachusetts without direct rail service and more than 10 Boston Proper work trips where the commuter rail share exceeded 60% were Rehoboth at 82%, North Attleborough at 74%, and Plainville at 64%. North Attleborough borders directly both on Attleboro, which has two rail stations, and on Mansfield, which has one. Rehoboth borders on Attleboro, but with a total of only 33 Boston Proper work trips, the mode split results are questionable. Plainville is separated by one town from Attleboro and from Mansfield. The South Attleboro, Attleboro, and Mansfield stations all have large parking lots, and the Attleboro Line has the fastest average travel speeds in the system. (As discussed above, a Bourne extension could provide average travel speeds comparable to those of the Attleboro Line.) Among other non-rail towns it is difficult to discern a pattern, except that the Attleboro/ Stoughton Line captured at least 24% of the Boston work trips from each Massachusetts town in its logical service area.

The only community in Rhode Island served directly by commuter rail service to Boston is Providence. Rhode Island towns south of Providence are comparable to Cape Cod towns in terms of distance from Boston and highway access, but most have no direct bus service to Boston. Residents of these Rhode Island communities use not only the Providence station but also several stations in Massachusetts. The overall rail share of Boston Proper work trips from these towns in 1990 was around 40%.

#### **Estimated Demand from Cape Cod Towns Excluding Bourne**

Excluding Bourne, there are 14 towns on Cape Cod. The 1990 Census figures show a total of 737 Boston Proper work trips from these towns, of which 74% originated in the top three. These were Barnstable (221 or 30%), Sandwich (174 or 24%) and Falmouth (145, or 20%). The next three, Mashpee, Yarmouth, and

Dennis, collectively accounted for another 20%. These are the six towns nearest to Bourne. The remaining eight Cape towns, Brewster, Harwich, Chatham, Orleans, Eastham, Wellfleet, Truro, and Provincetown, generated a total of only 50 Boston Proper work trips. (For comparison, the 282 Boston Proper work trips from Wareham exceeded the number from any individual town south of the canal.)

Based on the results above from towns served indirectly by commuter rail, it is reasonable to assume that the share of Boston Proper work trips from the six Cape Cod towns nearest Bourne that would be captured by a commuter rail extension would fall within the same limits assumed for Wareham and Bourne. At 76%, the combined rail and bus share from these towns would be 521, of which the estimated rail share would be 431. At 25%, the rail total would be 171. The mid-point between the lower and upper limits would be 301.

For the outer eight Cape towns, the nearest bus service with schedules suitable for Boston commuting is in Barnstable. Buses carried about 20% of the Boston Proper work trips from these towns in 1990. Since Buzzards Bay (or any other station in Bourne) would be even further away, and rail service would be less frequent than present bus service, it is unlikely that rail would attract a larger market share. At 20%, this would be 10 trips; at 10% it would be 5.

#### Estimated Demand from Other Towns North of Cape Cod Canal

Because of proximity to other commuter rail extensions currently planned or under construction, the potential service area of a Bourne extension north of the Cape Cod Canal would be limited. The only towns other than Wareham itself for which a station in Wareham would provide convenient service would be Marion, Mattapoisett, Rochester, and Carver. These are all relatively small generators of Boston Proper work trips, and the utility of a Wareham station would depend largely on its location and parking capacity.

Of the four towns, Carver had the most Boston Proper work trips in 1990, at 93, but population was most heavily concentrated in the northern third of the town. From there, the Middleborough/Lakeville or Plymouth Line stations would be much more convenient. Rochester, Marion, and Mattapoisett, had a combined total of 140 work trips to Boston Proper in 1990. A 76% share of this for combined rail and bus service would be 106, of which the estimated rail share would be 78. A 25% share would be 35. The mid-point of these would be 57.

## Estimated Extension Share of Other Boston Work-Trip Market at 1990 Travel Levels

### *Market Shares for Present Lines*

As discussed above, the commuter rail share of work trips to Boston is much lower for destinations outside Boston Proper than for those inside. According to the Census figures, the only two towns from which rail captured over 35% of work trips to Boston destinations outside Boston Proper were Rehoboth, at 61%, and Stow, at 50%. The rail shares from individual towns vary according to the locations of the destinations. The highest rail shares occur in the neighborhoods adjoining Boston Proper.

The 1993 survey results showed that 81% of commuter rail work trips to Boston neighborhoods outside Boston Proper were destined to Fenway/Parker Hill or South Boston, and 92% either to these neighborhoods or to Charlestown or North Dorchester. South Boston destinations were usually accessed either by walking or by transferring to an MBTA bus or private van at South Station. North Dorchester was accessed by transferring to the Red Line at South Station. Passengers using a Bourne extension would have the same options, and could also reach North Dorchester by transferring to the Red Line at Braintree or Quincy Center. Fenway/Parker Hill destinations for most survey passengers were accessed either by walking from Ruggles Station or by transferring to the Orange Line or a bus at Back Bay. Charlestown destinations were reached by transferring to the Orange Line at Back Bay. Trains on a Bourne extension would not pass through either Ruggles or Back Bay, so passengers destined for Fenway/Parker Hill or Charlestown would face additional transfers.

### *Estimated Demand from Bourne Extension*

Given the dominance of South Boston, Fenway/Parker Hill, Charlestown, and North Dorchester as destinations for commuter rail work trips to Boston outside Boston Proper, the demand estimates for the Bourne extension concentrated on trips to these neighborhoods. Because of the greater access distances to these neighborhoods than to destinations within Boston Proper, the commuter rail share would be lower. Therefore, using the same mode splits assumed for Boston Proper work trips should result in high estimates.

According to the Census figures, there were 94 work trips to the four specified neighborhoods from Wareham and 77 from Bourne in 1990, or a total of 171. A 76% rail and bus share of this would equal 130, of which the estimated rail share would be 104. A 25% rail share would equal 43, and the mid-point value would be 74. Assuming that this would account for 92% of the work trips to Boston outside Boston Proper from these two towns, add-ons to account for other destinations would have a mid-range value of 6. These figures would result in an estimated mid-point rail share of 22% of total work trips to all of Boston

outside Boston Proper from Wareham and Bourne. This is consistent with results from communities served by existing lines.

The six Cape Cod towns nearest Bourne had a total of 371 work trips to the four specified Boston neighborhoods. A 76% rail and bus share of this would equal 282 trips, of which the estimated rail share would be 248. A 25% share would be 93 trips. The mid-range value would be 171. The add-on for destinations to other neighborhoods would have a mid-range value of 15. The resulting mid-point rail share of total work trips to Boston outside Boston Proper from the six towns would be 22%.

The other eight Cape towns had a total of 60 work trips to the four specified neighborhoods. A 20% share of this would equal 12, and a 10% share would equal six, with a mid-point of 9. Add-ons to account for other destinations would add only one or two riders.

Rochester, Marion, and Mattapoisett, had a total of 63 work trips to the four specified neighborhoods. A 76% rail and share of this would equal 48 trips, with the rail share being 33. A 25% share would be 16 trips. The mid-range value would be 25. The add-on for destinations to other neighborhoods would only one or two trips.

#### **Estimated Extension Share of Cambridge Work-Trip Market at 1990 Travel Levels**

Among towns with South Side rail stations, the highest rail share of Cambridge work trips in 1990 was 55%, but shares of around 20% were most common. Wareham and Bourne both had relatively low total work-trip orientation to Cambridge, with 27 trips from Wareham and 7 from Bourne. (The latter number is expanded from such a small sample that it cannot be relied on.) The ratio of Cambridge work trips to Boston work trips for Wareham alone (.056) was lower than that for any town with existing South Side commuter rail service except Canton, with which it was tied. With such low total trip-making, assumptions about rail mode splits make little difference in overall demand estimates. A 55% share of Cambridge work trips from Bourne and Wareham would equal 19 trips, and a 20% share would equal seven.

Among towns served by South Side commuter rail lines but without stations within their borders, the highest share of Cambridge work trips was 37%. The total number of Cambridge work trips from several towns was too low to show any rail trips in the Census sample. For purposes of analysis, it is assumed that a Bourne extension would attract between 12% and 37% of the Cambridge work trips from the off-line towns in its service area, or about half the mode split levels assumed for Boston Proper destinations before adjusting for bus service. Census figures indicate that the express buses from the Bourne extension service area capture negligible shares of Cambridge work trips.)

The six Cape Cod towns nearest Bourne had a combined total of 75 Cambridge work trips in 1990. A 12% share of this would be 9. A 37% share would be 28. The mid-range value would be 19. The outer eight Cape towns had a total of 61 Cambridge work trips. At half the rate of Boston Proper trips, the rail share would range from 5% to 10%. This would be between three and six trips, with a mid-range of four.

The 1990 Census figures show no work trips to Cambridge from Rochester, Marion, or Mattapoisett. Although the sampling method may have missed some trips, it is probable that the actual number was low, and that the rail share of this market would not affect the demand estimated significantly.

### Estimated Extension Share of Other Work-Trip Markets at 1990 Travel Levels

#### *Potential Interzone Travel from Bourne Extension*

##### Markets Served

As discussed in Chapter 4, commuter service to Bourne would be operated by extending trains of the Middleborough/Lakeville line, which is scheduled to open in September 1997. The operating plan for this line calls for all trains to stop at the Middleborough/Lakeville Station, plus one station in Bridgewater, three in Brockton, one on the border of Randolph and Holbrook, and either the Braintree or Quincy Center Red Line stations. The extension itself would most likely include one station in Wareham and one to three stations in Bourne. Because of the relatively short distance between Buzzards Bay and Wareham (5.4 miles between the present Amtrak station sites) and the small population able to reach Buzzards Bay Station by means other than automobiles, interzone travel from one station to the other would be negligible. Likewise, little interzone ridership would be expected between stations at the Bourne Bridge or Sagamore and Buzzards Bay or Wareham. Therefore, the analysis concentrates on trips to stations from Middleborough/Lakeville north.

At present, there is no local bus service in Bridgewater or Middleborough. MBTA buses serve Randolph and Holbrook, but currently bypass the Randolph/Holbrook Station site by half a mile or more. Based on past experience at other stations, there would be insufficient demand to justify re-orienting the Randolph and Holbrook routes, or establishing new routes in Bridgewater or Middleborough, specifically to provide commuter rail connections.

Brockton Area Transit (BAT) buses provide connections throughout Brockton from a transfer center a few blocks from the site of the downtown Brockton commuter rail station. BAT service operates on a "pulse" schedule, intended to facilitate transfers among routes. In the A.M. peak, buses leave the transfer center on the hour and at 20 and 40 minutes past the hour on eight routes, and on

the hour and 40 minutes past on four routes. Commuter rail arrival times at Brockton will be constrained by the need to coordinate track use with the other Old Colony branches north of Braintree. This will result in non-uniform rail headways, which will not conform well with BAT scheduling strategy.

At either Braintree or Quincy Center, commuter rail passengers will be able to transfer to the Red Line. There will also be connections with two MBTA local bus routes at Braintree and with 14 at Quincy Center. Red Line service is sufficiently frequent during peak periods (every 7.5 minutes) that passengers transferring from inbound commuter rail trains would not have to be concerned with connecting with specific Red Line trips. Outbound passengers would, however, have to plan their arrivals to avoid missing commuter rail connections. Headways vary among the bus routes, and scheduled departure times are controlled by considerations that would outweigh attempted coordination with commuter rail service.

Because of expense, use of taxis for commuter rail access and egress is very limited, and occurs mostly on non-repetitive or infrequent trips. A few suburban employers provide van connections to commuter rail stations, but none of these serve many riders.

#### Demand Estimation Method

For reasons discussed above, most interzone trips ending at stations on the Middleborough/Lakeville commuter rail line would have to be completed by walking from the alighting station to the final destination. Therefore, it is reasonable to base demand estimates on potential rail share of trips to points within walking distance of stations. In the 1993 commuter rail survey, among interzone passengers walking to their final destinations, fewer than 5% reported walking times of over 20 minutes, or about one mile. This was apparently a reflection of unwillingness of passengers to walk greater distances rather than of a lack of possible destinations more than a mile from a station. Destinations of walking egress trips from stations on the Middleborough/Lakeville line would presumably also be confined mostly to areas within one mile of stations. In Quincy, trips within walking distance of any Red Line station can be included as well, since transfers would involve relatively little delay.

At present, the only way to travel by transit from Wareham or any of the towns on Cape Cod to any of the cities and towns with stations on the Middleborough/Lakeville line would be to ride an express bus into downtown Boston and transfer to another express bus or to the Red Line. Such trips would be so time-consuming that it is unlikely that any are made on a regular basis. (Census journey-to-work reports support this assumption.) Therefore, any interzone trips captured by commuter rail would be diverted from automobiles.



Trips to most of the destinations in the corridor are most likely to be made by driving on Routes 25, I-495 and 24. Trips to Braintree or Quincy could also be made via Route 3. Only trips to Quincy would use the Southeast Expressway. Those to most other locations would be made under free-flowing traffic conditions. At most suburban work locations there is either free or low-cost parking. Auto commuters typically look at out-of-pocket travel expenses rather than fully-allocated costs when considering alternatives to driving. Under such conditions, there would be little incentive for present automobile users to shift to commuter rail.

The 1993 commuter rail survey results showed that of passengers making interzone commuter rail trips, only 40% had autos available for those trips. In contrast, among commuter rail riders making non-interzone trips, 82% had autos available. Interzone riders also used commuter rail less often on average, with 24% reporting use three days per week or less, 34% four days per week or less, and 66% five days per week or more. The corresponding figures for non-interzone riders were 14%, 23%, and 77%. These findings further illustrate the lower ability of commuter rail to attract non-Boston trips.

Given the findings above, interzone travel demand estimates for the Bourne extension should assume a much lower market share range than that used for Boston trips. A low estimate of 5% and a high estimate of 10% have been used below.

### **Estimated Demand**

Census Journey-to-Work figures are based on expanded sample data. The more finely origins and destinations are broken down by geographic area, the less reliable the results are. Data for work trips from homes in Wareham, Bourne and other Cape towns to work locations in communities along the Middleborough/Lakeville commuter rail line are available by town of origin to Census tract and block group of destination but cannot be further subdivided with any accuracy. In 1990 there were 433 work trips from Wareham and Bourne to block groups within one mile of stations on the Middleborough/Lakeville line or Red Line stations in Quincy. A 5% share of this market for commuter rail would equal 22 trips per day. A 10% share would be 43 trips.

Other Cape Cod towns from which interzone trips to stations on the Middleborough/Lakeville line might be attracted include Falmouth, Mashpee, Sandwich, Barnstable, Yarmouth, and Dennis. The 1990 Census figures show a total of 309 work trips from these towns to the same destinations examined for Wareham and Bourne. A 5% share of this market for commuter rail would equal 15 trips per day, and a 10% share would be 31 trips. Adding these to the Wareham and Bourne totals would result in a low-end estimate of 37, and a high-end estimate of 74, with a mid-range value of 56.

The Wareham and Bourne figures would account for 59% of the low interzone and 58% of the high estimate, but the proportion of interzone trips drawn from the towns where stations are located is typically much higher than this. Among interzone passengers in the 1993 survey, 83% reported trip origins in the same towns as their boarding stations. Similar results for the Bourne extension would produce a range of 27 to 52 interzone trips, with a mid-range value of 40.

#### Potential Travel to Points Beyond Boston

The 1993 commuter rail survey found that 98.1% of the work trip destinations on South Side Commuter rail lines were in either Boston or Cambridge. Another 0.6% consisted either of interzone trips specific to individual lines, or of trips to Braintree or Quincy, which have already been estimated above for the Bourne extension. This leaves 1.3% of work trips to be accounted for by other destinations reached by transferring from commuter rail to other modes in Boston. After adjusting for express bus service, the demand estimates above range from 540 to 1,345 work trips per day. If this accounts for 98.7% of the total, work trips to other destinations would add between 7 and 17 trips, with a mid-range of 12.

#### Estimated Extension Share of Non-Work Trips

Little information is available on origins and destinations of non-work trips. Therefore, it is necessary to estimate these on the basis of typical ratios of non-work trips to work trips. The 1993 commuter rail survey found that home-to-work trips accounted for 86% of all inbound ridership. On seven of the nine system routes, including all of those on the South Side, home-to-work trips ranged between 84% and 90% of the total. On the Fitchburg and Lowell lines, the values were 75% and 76%. The high rate of non-work trips on the Fitchburg Line was mostly the result of an unusually large number of colleges and private schools within walking distance of stations. On the Lowell Line, many of the non-work responses were from passengers going to an evening event at Boston Garden. The pattern on a Bourne extension would be more likely to fall within the range found on the lines other than Fitchburg and Lowell.

In the preceding subsections, estimates of home-to-work trips to all destinations total 546 for the minimum mode-split case, and 1,362 for the maximum case. A minimum value for ridership by all trip purposes is obtained by assuming that 546 home-to-work trips would represent 90% of all trips. This would make the total 607. A maximum value for ridership by all trip purposes is obtained by assuming that 1,362 home-to-work trips would represent 84% of all trips. This would make the total 1,621. The average of these high and low estimates would be 1,114.

### Estimated Changes in Travel Patterns from 1990 to 1996 and Future Years

As discussed above, work trips to Boston would account for the largest portion by far of ridership on a Bourne commuter rail extension. Therefore, in estimating ridership in future years, it is most important to examine changes in work travel. The most comprehensive information on work trips is that provided by the U.S. Census Journey-to-Work survey. This is conducted in conjunction with the regular decennial Census, so the most recent figures available are from 1990. Some changes in travel patterns would be expected in the six years since these figures were collected, and institution of commuter rail service implies a relatively long-term investment in fixed facilities. Thus, it is important to try to update the 1990 figures both to the present and to various future years.

#### *Adjustment from 1990 to 1996*

Between census years, the Census Bureau prepares estimates of population for states, counties, and municipalities at two-year intervals. Town-level figures are based largely on a sampling of information contained in income tax returns. The estimation process takes considerable time to complete. The most recent estimates are for population as of July 1, 1994, and these were released in the fall of 1995. These estimates do not include any journey-to-work information.

According to the Census estimates, most of the towns that would be served by a Bourne extension had fairly small population increases between 1990 and 1994, with average gains of 5.1%. In Barnstable County, the only towns with increases of more than 10% were Sandwich at 15%, and Mashpee at 21%. Among the towns north of the canal that would be served by the extension, only Rochester, with a gain of 12%, grew by over 10%.

In the two years between 1994 and 1996, population has continued to grow, but Census estimates for 1996 will not be available in time to use in this study. If it is assumed that the average absolute increase per year in each town was the same from 1994 to 1996 as it was from 1990 to 1994, this would result in a gain of 7.7% for the service area as a whole from 1990 to 1996. Weighted by the distribution of commuter rail trips among origin towns, the growth rate would be 9.9%.

It appears unlikely that Boston workers accounted for a disproportionately large share of new residents of the Bourne extension service area. In fact, the opposite is more likely. Much of the population of the Cape consists of retirees, and this segment is growing. Figures from the Massachusetts Department of Employment and Training show a decrease in total Boston employment for several years after 1990, but employment has now recovered to about the same level as in 1990. Work trips to destinations outside Boston account for such small shares of the estimated commuter rail ridership that varying assumptions about the growth rates make little difference in the overall totals.

High-end estimates of ridership for 1996 and subsequent years are obtained by using as a base the 1990 high-end estimates, (which include the largest factors for commuter rail shares of work travel and for ratios of non-work to work trips), and applying the population growth rates for each town. Low-end estimates are obtained starting from the 1990 low-end estimates and assuming that growth would not exceed the rate of increase in overall Boston employment.

The percent of residents employed in Boston and the projected rail shares of these trips both vary among towns in the Bourne extension service area. Applying the 1990-1996 population growth rates for individual towns to the projected ridership from these towns based on 1990 work trips would result in an upper-bound estimate of 1,785 weekday inbound rail trips for all purposes at 1996 travel levels. The lower-bound estimate, constrained by Boston employment, is 615. The mid-point of these values would be 1,200.

### *Projected Demand for Years 2010 and 2020*

Projections of population for each Regional Planning District in Massachusetts for the years 2010 and 2020 have been prepared by the Massachusetts Institute of Social and Economic Research (MISER). All Cape Cod towns are in the Cape Cod Regional Planning District (CCC). Wareham, Rochester, Marion, and Mattapoisett are all in the Southeast Regional Planning District (SRPEDD). For the CCC as a whole, MISER projects a population increase of 17.3% from 1990 to 2010, and 24.6% from 1990 to 2020. For the SRPEDD as a whole, the projections are 11.6% and 14.0%.

Projections of work trips to Boston from these areas have not been prepared. The CCC and SRPEDD areas are both net exporters of workers. That is, the total number of work-force participants residing in each area exceeds the number of jobs located within that area. The MISER forecasts assume that the ratios of jobs to workers within each area will remain essentially constant. Under this scenario, there would not have to be any increase in the proportion of workers residing in the CCC or SRPEDD who are forced to go to outside locations such as Boston and Cambridge to find work. Because of increasing numbers of retirees, the percentage of CCC residents in the work force is expected to drop from 65% in 2000 to 59% in 2020. The change in SRPEDD as a whole will be smaller, from 55% to 52%. MAPC projections indicate that the number of jobs within the city of Boston will increase by 8.7% between 1990 and 2010, or at about half the rate of the projected CCC population growth in the same time span. Between 2010 and 2020, MAPC projects a net decrease in Boston employment, resulting in only 5% more jobs than in 1990. All of these trends indicate that Boston work trips from the CCC and SRPEDD areas will increase at slower rates slower than those of their population growth.

Using methods similar to those described above for the 1994 and 1996 estimates, high-end estimates for weekday inbound ridership on the Bourne extension

assuming continued bus service would be 1,868 in 2010 and 1,961 in 2020. Low-end estimates would be 665 in 2010 and 645 in 2020. The lower total in 2020 compared to 2010 is the result of the projected decrease in total Boston employment in this time. The mid-points of the low and bus-constrained high estimates would be 1,265 in 2010 and 1,305 in 2020.



## **APPENDIX E - AIR QUALITY IMPACT ESTIMATION METHODOLOGY**

### **Present VMT for Bourne Extension Riders**

According to the 1990 Census Journey-to-Work figures, the most common mode of travel for work trips to Boston and Cambridge from the market area of the Bourne extension was driving alone, at 61.4% of the total. Private-carrier bus services were second at 18.4%, followed closely by carpooling at 16.2%. Most of the remaining 4.0% of trips were completed by using transit services that did not serve the extension corridor directly, and therefore required long auto-access trips.

The opening of the Old Colony Middleborough/Lakeville and Plymouth lines in September 1997 will alter the range of options open to commuters from the Bourne extension corridor. The ridership projections in the Old Colony EIR imply that the Old Colony lines will capture 5.7% of the Boston and Cambridge work trips from the service area of a Bourne extension corridor if the extension is not built. The EIR does not provide breakdowns of prior modes of these riders. Given the relatively long access distances to Old Colony stations from the Bourne extension corridor, these riders would be most likely to be diverted from drive-alone auto trips, reducing the share for that mode to 55.7%.

In calculating the base-case VMT for a Bourne extension, the first step was to allocate passengers to prior modes in the same proportion as the 1990 Census figures. The drive-alone total was then adjusted downward to reflect the number of passengers expected to divert to Middleborough/Lakeville and Kingston when the Old Colony stations there open. It was further assumed that all passengers with trip origins closer to a station on a Bourne extension than to Middleborough/Lakeville or Kingston would be diverted to the extension. Diversions from bus service were limited to about 40% of bus ridership, based on past experience in other corridors. Diversions from other sources were adjusted accordingly.

The daily VMT for a single-occupant auto trip is equal to the round-trip distance from origin to destination (ignoring differences between parking locations and trip ends.) The VMT for a carpool trip is equal to the round trip distance for the vehicle driver. (Because of diversions to pick up other passengers, this would be somewhat longer than the length of the same trip for a single-occupant vehicle.)

The most conservative estimates of VMT reductions for a Bourne extension are obtained by using minimum reasonable values for VMT generated in the base-case by those who would divert to rail and maximum reasonable values for VMT generated in accessing the rail extension. This includes an assumption that diversions of car-poolers to commuter rail would not result in any change in VMT by the carpool vehicles; they would continue to make the same trips, but with fewer passengers per car.

Because of the low population densities of Cape Cod towns and the limited-stop configuration of existing bus service, it is necessary for a majority of bus passengers either to use park-and-ride lots or to be dropped off at stops. Commuter rail extensions examined in this study would have even fewer stops than the bus service, requiring longer average access distance. Bus passengers most likely to divert from bus to rail would be those that currently use bus park-and-ride facilities, as they implicitly have the greatest flexibility in boarding locations. Therefore, it is reasonable to assume the base-case VMT for most express bus passengers diverted to rail to be equal to the round-trip distance from origin to present boarding stop. The main exceptions to this would be passengers currently walking to the bus stops at Buzzards Bay and Wareham that are at or near the same locations as rail stations. For these passengers, there would be no base-case VMT. The number of passengers diverted to the rail extension from transit services not serving the corridor directly would be so small that their VMT changes can be ignored.

#### VMT for Bourne Extension Access

For a mass transit trip, VMT generation depends on the access modes and access distances of the passengers. The Census figures do not provide breakdowns of these for existing services, but breakdowns for the commuter rail extension have been calculated as part of the demand analysis. Passengers walking to transit stops would generate no VMT. Passengers driving to park-and-ride lots would have VMT equal to the round trip distance from origin to parking lot. Passengers picked up and dropped off at stops by auto drivers making special trips for this purpose would have VMT equal to twice the round-trip distance from origin to boarding point. Passengers dropped off and picked up by drivers making trips for other purposes at the same time would generate little or no VMT.

The percentage of riders using drop-off access varies widely among stations on present MBTA commuter rail lines. The 1993 survey found that drop-offs accounted for between 10% and 20% of access trips at two thirds of all stations, but the overall range was from 0% to 35%. Drop-off rates below 10% were most common at stations in areas with relatively high population density and close station spacing. These characteristics would not be present on the Bourne extension. Reasons for above-average drop-off rates were less clear, but appeared to be most closely associated with constrained parking or above-average parking fees. Only four stations (Lawrence, Wilmington, Shirley, and Providence) had drop-off rates above 26%.

For the system as a whole, 43% of drop-offs had access times of five minutes or less, 76% ten minutes or less, and 89% 15 minutes or less. An examination of the responses with times over 15 minutes suggests that most of the passengers had atypical travel requirements. The survey did not distinguish between drop-offs made as special trips and drop-offs made in conjunction with other trips. Many



of the drop-off trips with access times over 15 minutes did not use the stations nearest the origins, strongly suggesting that they were made in conjunction with trips for other purposes. Drop-off trips with long access times were also likely to be made less frequently than trips with shorter times. There were almost no cases of drop-off trips to any one station from any one area over 20 minutes away being reported by more than one survey respondent. The median access time for drop-offs was about seven minutes. At an average speed of 30 m.p.h., the average length of drop-off access trips would be about 3.5 miles one way.

From the results above, it is reasonable to assume that the proportion of access trips to each station on a Bourne extension made by drop-offs would not exceed the highest rate found at any existing station, or 35%, and that trips to stations on the extension would also come from locations within 15 minutes driving time. For Buzzards Bay Station, this would consist of points within Bourne, Sandwich, and the northern edge of Falmouth. The ridership projections indicate that passengers from these origins accessing Buzzards Bay Station by all modes except walking would account for 37% of the total boardings there. If these were all drop-offs, and accounted for 90% of the drop-off total, then 41% of the station access trips would be by drop-off. Therefore, a 35% drop-off rate would be possible, although fairly unlikely.

For a Wareham Station, the 15-minute driving access area would include Wareham and portions of Rochester and Marion. Passengers from these origins accessing Wareham Station by all modes except walking would account for 80% of the boardings there, so a 35% drop-off rate would also be possible there.

Using the assumptions described above on sources of ridership on a Bourne extension terminating at Buzzards Bay and access modes to the stations, VMT reductions were calculated for the mid-point demand estimate. This would result in a net reduction of 53,350 VMT per weekday. This value is relatively insensitive to changes in assumptions on proportions of drop-offs, which have the most uncertainty of any of the VMT components. Reducing the drop-off rate from 35% to 15% at both Buzzards Bay and Wareham would increase the VMT reduction by about 4%.



## APPENDIX F - HISTORY OF CAPE COD - BOSTON PUBLIC TRANSPORTATION SERVICE

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### Previous Rail Passenger Service

Railroad passenger service between Cape Cod and Boston was first established in 1848, with the completion of a rail line from Middleborough through Buzzards Bay to Sandwich. Subsequent extensions brought service to Hyannis in 1854, Woods Hole in 1872, and Provincetown in 1873. Service to and from Boston on these lines was always oriented primarily for non-work travel, but schedules suitable for Boston commuting were introduced in the 1890s. Service peaked around 1910, but was cut substantially beginning during World War I. Chronic unprofitability and lack of support for government subsidies resulted in the complete discontinuance of Boston-Cape Cod rail passenger service in 1959. At the end, there were three round trips a day between Boston and Hyannis, including one inbound A.M. peak and one outbound P.M. peak trips, with Woods Hole sections splitting at Buzzards Bay.

### Express Bus Service

The towns that would be served by a Bourne commuter rail extension currently have a well-established network of private-carrier express bus routes. This network evolved in response to cutbacks in rail passenger service to southeastern Massachusetts and Cape Cod after World War II, and the complete cessation of commuter rail service to this region in 1959. Like the former rail service, these bus lines initially served large numbers of local stops, accessed predominantly by walking. Recent years have seen consolidation of bus service at much smaller numbers of stops with reliance on park-and-ride or drop-off auto access. Future rail service would use a similar station strategy.

The origins of the present bus service to Boston from Cape Cod and other points in the market area of a Bourne commuter rail extension date from 1951. In May of that year, Almeida Bus Lines was authorized by the state Department of Public Utilities to operate buses to Boston on two routes, one from Hyannis and one from Otis Air Force Base in Bourne. Both of these routes ran mostly on old state highways. Between the Bourne Bridge and Boston, the alignment was the present Routes 28, 27, and 138. South of the bridge, the Otis route continued on Route 28, while the Hyannis route used the present Route 6A. The Hyannis route included stops at Barnstable and Sandwich. Buses on both routes made intermediate stops at Buzzards Bay, Onset, and downtown Wareham.

A third route from the Cape to Boston began in September 1951, when the Plymouth & Brockton Street Railway Company was authorized to extend its existing Boston-Plymouth route to Sagamore Circle via the present Route 3A. North of Plymouth, the present Route 53 was used to Quincy, where Route 3A was rejoined. The south end of this route included an extension from Sagamore

Circle to Buzzards Bay via Route 6, but P&B was not permitted to carry through passengers between Boston and Buzzards Bay.

Following the construction of the Mid-Cape Highway between the Bourne Bridge and Barnstable in 1958, Almeida shifted some peak-hour Hyannis trips to that route, but most service remained on Route 6A.

Rail passenger service between Boston and Cape Cod points ended on June 30, 1959. As a replacement for the Woods Hole branch of this service, Almeida's Otis Air Force Base-Boston route was extended to Woods Hole via the present Route 28A and local roads. In 1960, Almeida began running some Hyannis trips to Boston via the Sagamore Bridge and Routes 3A and 53 and the Southeast Expressway. This service was shifted to the present Route 3 as sections of that highway were completed between 1961 and 1963. At about the same time, stops were added at Sagamore Circle, downtown Sagamore, East Sandwich, and West Barnstable. Routing of Hyannis service via Buzzards Bay and Wareham was discontinued.

In 1961, the Plymouth & Brockton route from Sagamore Circle to Boston was extended to Hyannis via the Mid-Cape Highway, with an intermediate stop at Route 132 in Barnstable. Some P&B Hyannis service was shifted to the present Route 3 north of Sagamore between 1961 and 1963. Most trips were run as extensions of Boston-Plymouth service until about 1970, however.

Almeida's Woods Hole - Boston route was shifted to the present Routes I-495, 24, and I-93 north of Middleborough as sections of this highway were completed between 1959 and 1963. Service south of Middleborough continued to use Route 28. In the early 1960s stops were added at Pocasset, Monument Beach, West Wareham, South Middleborough and Rock Village. In 1963, operation between Otis AFB and Falmouth via the present Route 28 was authorized, but some trips continued running between these points via Route 28A, to serve North and West Falmouth. In 1969, following completion of the present Route I-495 between Middleborough and Wareham, most Woods Hole service was moved to this alignment. Some local trips remained on Route 28 to serve local stops.

In 1978, Almeida Bus Lines sold the Woods Hole-Boston route to Bonanza Bus Lines. Bonanza immediately eliminated the local-service variations. This ended service to West Falmouth, North Falmouth, Pocasset, Monument Beach, Onset, West Wareham, South Middleborough and Rock Village. After about 1970, South Middleborough and West Wareham had had no service suitable for Boston work trips. One outbound P.M. peak trip had stopped at Rock, but there was no inbound A.M. peak service there. Inbound A.M. peak service had been discontinued at North Falmouth in 1976, and at West Falmouth about 1970.

Almeida Bus Lines went out of business in 1979, leaving Plymouth & Brockton as the only operator of Hyannis-Boston service. This resulted in the end of local bus

service on Route 6A, including the stops at downtown Sagamore, Sandwich, East Sandwich, and West Barnstable. Schedules suitable for Boston commuting from these stops had been discontinued in the early 1960s. Almeida stops on Route 6 at Route 130 in Sandwich and at Route 149 in West Barnstable, with service suitable for Boston commuting, had been discontinued in 1976.

In 1984, Bonanza replaced the downtown Wareham stop on the Woods Hole route with a stop at a new park-and-ride lot at the Wareham exit to Route 25. In 1987, following the completion of Route 25 from Wareham to the Bourne Bridge, Bonanza split the Woods Hole route into separate routes to Boston from Woods Hole and from Buzzards Bay. The Woods Hole route included the old stops at Falmouth and Otis Air Force Base. A new stop for Bourne was established at a supermarket on Trowbridge Road near the south end of the Bourne Bridge. Most trips on this route ran non-stop between there and Boston.

The new Buzzards Bay route included stops at downtown Wareham and at the Millpond Diner on Route 28 at Tihonet Road. The stop at the park-and-ride lot at Route 25 in Wareham was discontinued. Some short-turns were run between Wareham and Boston. Service on this route was reduced several times in the next few years. By 1991 only two inbound trips and one outbound ran through to Buzzards Bay.

The South Station bus terminal has been the only downtown Boston stop on the Bonanza Cape Cod routes since December 1995. Bonanza's Boston terminal had been the Back Bay railroad station since the spring of 1990. Prior to that, Bonanza had used the old Greyhound terminal on Saint James Avenue. Almeida Bus Lines used the old Trailways terminal in Park Square before Bonanza acquired the service.

Plymouth & Brockton's Cape Cod service has included stops near both South Station and Park Square since 1960. Prior to that, the only stop was at the old Greyhound Terminal.

Bus service to Boston intended for commuting from Cape Cod points east of Hyannis has either never been operated or has been short-lived.

